



INSTRUCTION MANUAL

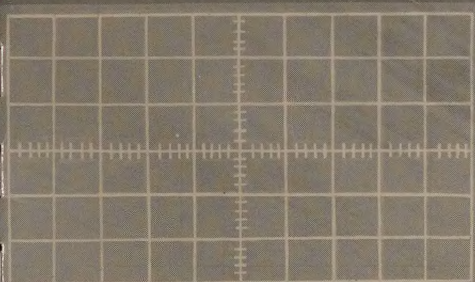
SYNCHROSCOPE SS-200

663

ASTIG

TRACE
ROTATION

SS-200 SYNCHROSCOPE



STY

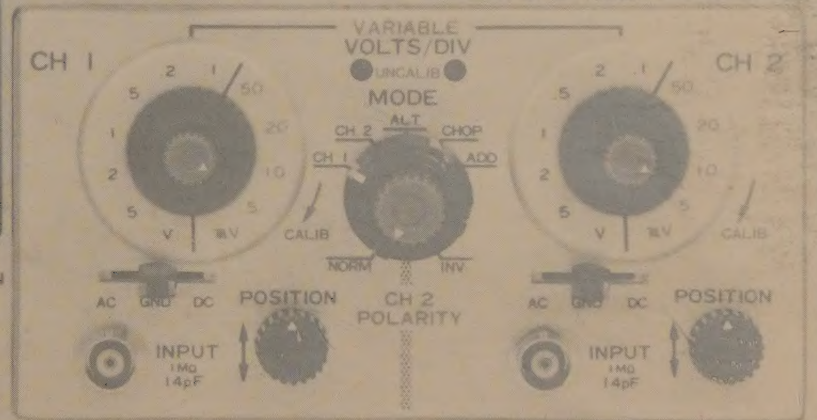
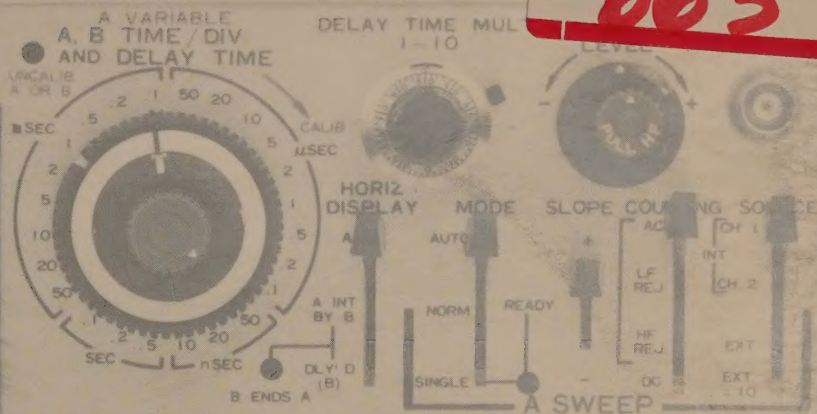
FOCUS

SCALE
ILLUM

POWER
ON

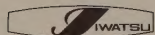
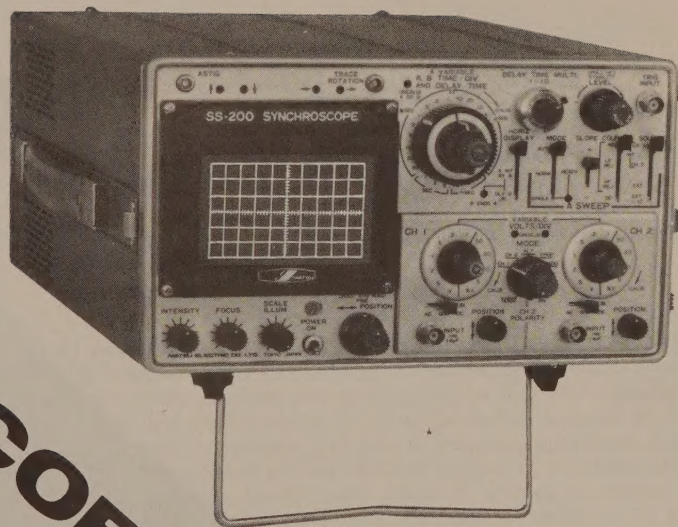
(PULL XTO MAG)
FINE
POSITION

ELECTRIC CO. LTD. TOKYO JAPAN



SYNCHROSCOPE

SS-200



IWATSU ELECTRIC CO., LTD.

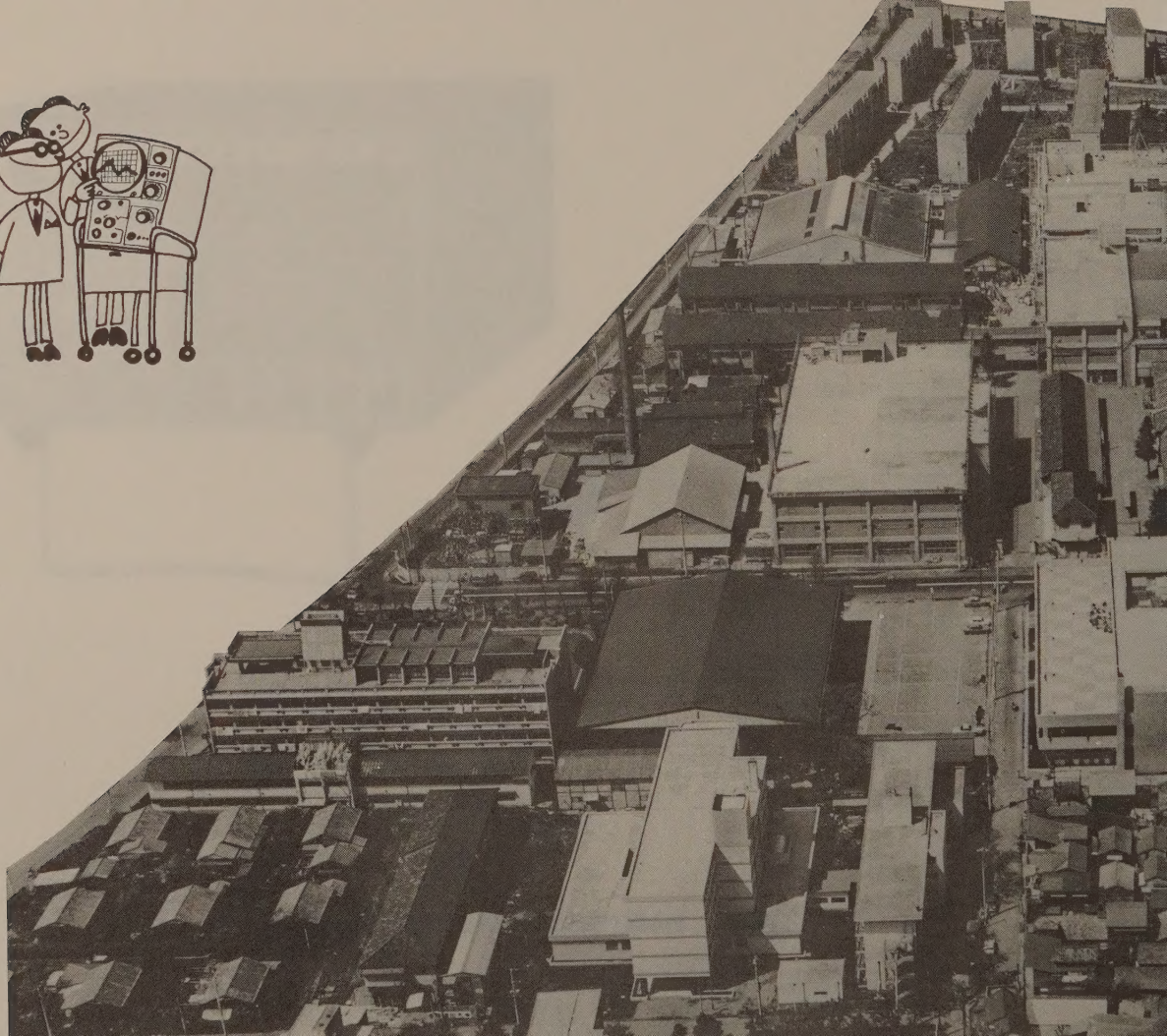
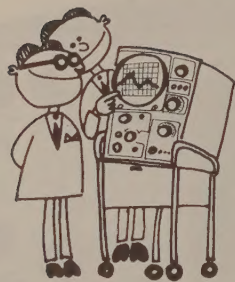
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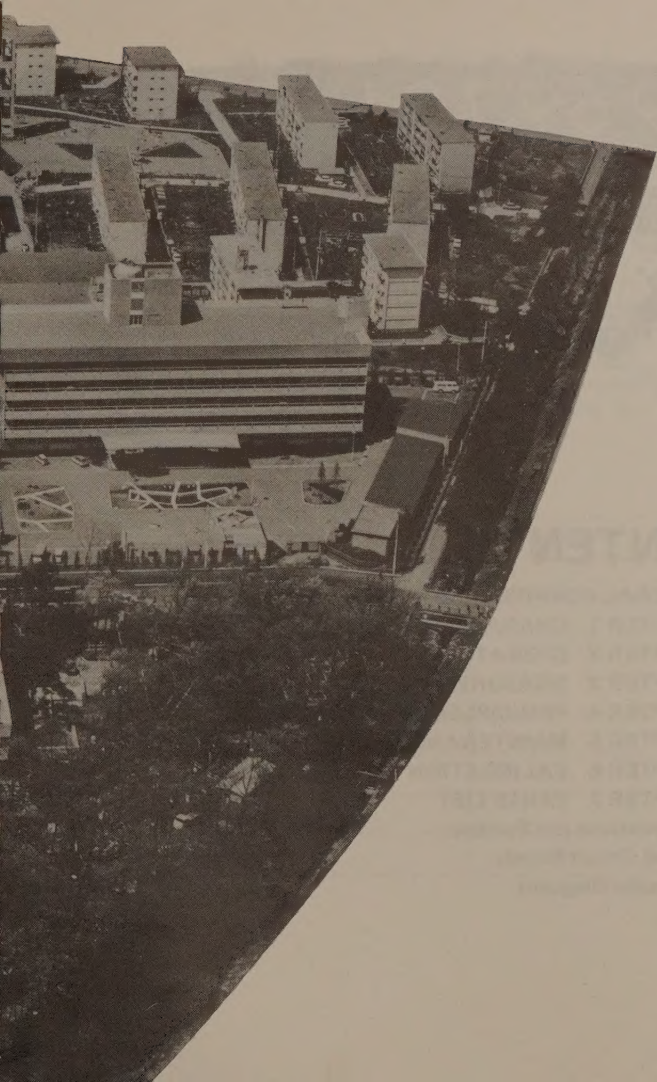
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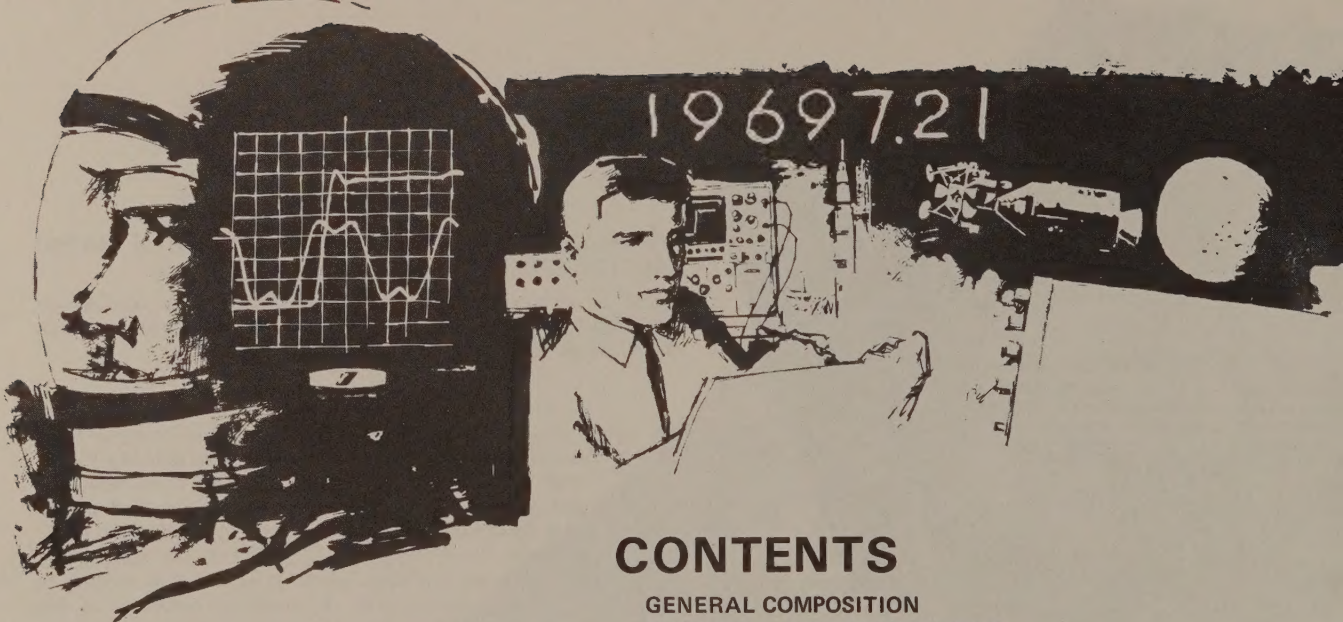
NOTICE

This Instruction Manual was translated and edited by IWATSU ELECTRIC CO., LTD.

While all procedures described herein have been verified by IWATSU/E-H, minor errors in translation may exist. In such event, please IWATSU/E-H.

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All Iwatsu products are warranted for a period of one year from date of delivery, but not exceed 18 months after delivery F.O.B. Japan. These products are warranted to be free from defects in material and workmanship, suitable for normal use and service under normal conditions, and able to meet any applicable specifications accepted in writing by IWATSU/E-H. No claim under the warranty will be accepted unless it is made in writing to IWATSU/E-H immediately after discovery of defect or in any case, within one year of delivery. No other warranty, express or implied exists outside this warranty. IWATSU/E-H are not liable for any commercial loss or other consequential damages incurred or sustained as a result of any defective or nonconforming product. IWATSU/E-H's obligation with respect to losses is limited under this warranty, at IWATSU/E-H's option, either to the replacement (by delivery F.O.B.) or repair of its manufactured products which prove to be defective or nonconforming. This warranty does not apply to any products improperly applied or used or which have been subjected to intentional or negligent misuse or accident, or which have been in any way modified by others without the express written agreement of IWATSU/E-H.



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GENERAL

The SS-200 SYNCHROSCOPE is a compact, lightweight, and portable synchroscope of simplified operation.

The electronically switched dual-trace vertical deflection system features wide bandwidth (DC to 200 MHz) with high sensitivity (10 mV/div) for both channels. Extremely high stability is obtained by the use of junction type FET (Field Effect Transistor) in the input circuit. Measurements can be performed only 15 seconds after switching the power on.

Description	Quantity
Coaxial Cable (BB-500)	1
Jumper Cable	1
Probe (1020)	2
200 earth lead	1
Polarized Filter	1
Post adaptor (C)	2
Fuse (1 A slow-blow)	2
Screwdriver (—)	1

The horizontal deflection system provides a trigger signal which allows synchronization of signal from DC to 200 MHz. Single sweep mode is also available.

The 4-inch rectangular CRT with an internal graticule provides a 6 div (Y axis) x 10 div (X axis) parallax-free display (1 div = 8 mm).

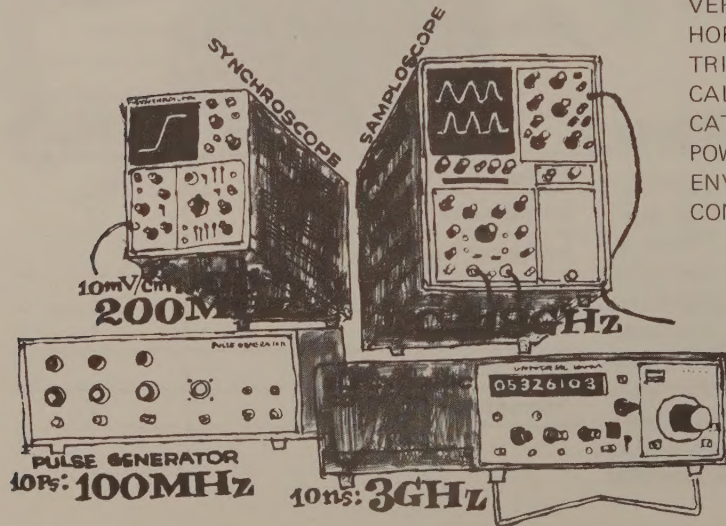
COMPOSITION

The instrument includes the following accessories:

Description	Quantity
Hexagonal Wrench (4 mm)	1
Hexagonal Wrench (3 mm)	1
Hexagonal Wrench (No. 2 — UNC)	1
Dust Cover	1
Accessory Bag	1
Instruction Manual	1
Inspection Report	1

CHAPTER 1 CHARACTERISTICS

In this chapter, the performance of the instrument is described briefly. Refer to "Description of Panel Controls" in Chapter 2, for information on the controls and connectors mentioned in this chapter.



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VERTICAL DEFLECTION SYSTEM

The preamplifier of the vertical deflection system comprises an electronically switched dual-trace system. The characteristics and accuracy in the following description are applicable to both CH1 and CH2 unless otherwise specified.

DEFLECTION SENSITIVITY

Ten (10) calibrated ranges from 5 mV/div to 5 V/div are provided to ensure an optimum deflection sensitivity for any measurement. In other words, the maximum deflection sensitivity which has been calibrated at the factory is 5 mV/div. Variable attenuation is possible with the VARIABLE control which decreases the sensitivity 1/2.5 (or more) of the calibrated value in each range. Thus the instrument can be used in the range of 5 mV/div to 12.5 V/div.

BANDWIDTH

The bandwidth corresponding to the position of the AC-GND-DC switch is shown in Table 1-1.

Table 1-1

VOLTS/DIV	Coupling Mode	Bandwidth	Performance
5 mV/div	DC	DC — 130 MHz	Within —3 dB
	AC	3 Hz — 130 MHz	
10 mV/div — 5 V/div	DC	DC — 200 MHz	Within —3 dB
	AC	3 Hz — 200 MHz	

RISE TIME

$$1.75 \text{ nsec (nsec = nanosecond} = 10^{-9} \text{ second)}$$

SQUARE WAVE CHARACTERISTICS

The square wave characteristics are shown in Table 1-2. The values shown are for an input square wave with a rise time of less than 300 psec (psec = picosecond = 10^{-12} second) except for the input signal for sag (the input square wave for sag 60 Hz has rise time of less than 20 nsec).

Table 1-2

Square waves	Characteristics
Overshoot	5 % or less
Undershoot	3 % or less
Ringing	3 % or less
Matching distortion	3 % or less
Sag (at 1 MHz)	2 % or less
Sag (at 60 Hz)	2 % or less

SIGNAL DELAY TIME

Approximately 80 nsec

INPUT SIGNAL COUPLING MODE

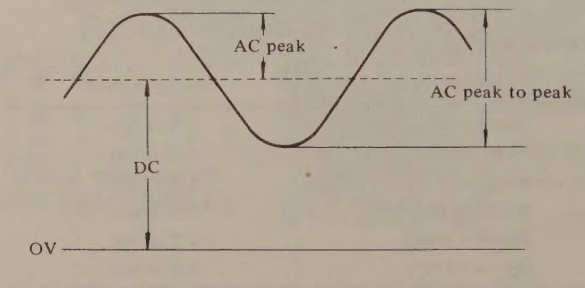
Three (3) coupling modes AC, DC, and GND (to identify the ground potential on display) are available.

In the DC position, the input signal is coupled directly to the vertical amplifier; in the AC position, it is coupled through a blocking capacitor. Attenuation for low AC frequency in the AC position is -3 dB at approximately 3 Hz.

INPUT IMPEDANCE

Direct	1 M Ω shunted by 14pF
With probe (10:1)	10M Ω shunted by 10pF

Figure 1-1



MAXIMUM INPUT VOLTAGE

The maximum input voltage of the signal to be measured (hereafter referred to as input signal) is 500 V in each range of the VOLTS/DIV switch. (DC + AC peak or AC peak-to-peak Refer to Fig. 1-1.)

MODE SELECTION

CH1	CH1 only
CH2	CH2 only
ALT	Alternate sweep of CH1 and CH2
CHOP	Chopped switching (at approx. 1 MHz)
ADD	(CH1 $\pm$ CH2)

POLARITY INVERSION

The polarity of the CH2 display can be switched to Normal or Invert.

COMMON MODE REJECTION RATIO

In the ADD (CH1 - CH2) mode, CH1 and CH2 form a differential input circuit. The common mode rejection ratio in this mode is more than 20 : 1 (for an input signal of 10 MHz).

LINEARITY

When a signal (sine wave) displayed at the center of the

CRT with a vertical amplitude of 2 div is moved to the top and bottom of the horizontal graticule scale, the variation in the vertical amplitude of the display is shown in Table 1-3.

Table 1-3

Frequency	Linearity
100 kHz or less	Within $\pm 3\%$ (2 div ± 0.06 div)
200 MHz	Within $\pm 5\%$ (2 div ± 0.1 div)

DRIFT

The drift, or vertical shift of a display is within 2 mV/hour when measured 30 minutes after the power is applied.

CH2 OUT SIGNAL

The input signal fed to the CH2 INPUT is amplified by five and is available at the CH2 OUT terminal.

The performance shown in Table 1-4 is obtained when the CH2 OUT is connected to the CH1 INPUT (cascade connection of CH1 and CH2), and both VOLTS/DIV switches are in the 5 mV/div positions with the VARIABLE control in the CALIB position.

Table 1-4

Item	Characteristic and Accuracy
Sensitivity	1 mV/div $\pm 3\%$
Bandwidth	DC - 30 MHz -3 dB
Noise	0.3 div or less

INTERNAL TRIGGER SECTION

To insure stable triggering in internally triggered dual-trace measurement, the trigger signal can be selected from either CH1 or CH2.

HORIZONTAL DEFLECTION SYSTEM

The horizontal deflection system provides three functions.

- Main Sweep (A Sweep)
- Sweep Delay (A INT BY B)
- Delayed Sweep [DLY'D (B)]

A SWEEP TIME (A TIME/DIV)

Twenty-four (24) calibrated sweep times from 10 nsec/div to .5 sec/div are available. Continuous variation of the sweep time is also possible by using the A VARIABLE control which reduces the rated sweep time by 1/2.5 times (or more). The lowest sweep time is 1.25 sec/div (or more).

The accuracy of each sweep time with A VARIABLE control in the CALIB position is within $\pm 3\%$ of the rated value.

B SWEEP TIME (B TIME/DIV)

Twenty-four (24) calibrated sweep times from 10 nsec/div to .5 sec/div are available and the B VARIABLE control on the right side panel functions in a manner similar to A VARIABLE.

The accuracy of each sweep time with B VARIABLE control in the CALIB position is within $\pm 3\%$ of the rated value.

SWEEP LINEARITY

The linearity of both the A and B sweeps at any position of the TIME/DIV switch is within $\pm 3\%$ of the rated value. (Within the area ± 4 div's from the center of the CRT screen.)

SWEEP MAGNIFIER

Pull the (PULL $\times 10$ MAG) FINE control to magnify the horizontal display by 10 times from the center of the CRT.

The time and linearity of the magnified sweep differ depending on the positions of A or B TIME/DIV, which are shown in Table 1-5.

Table 1-5

TIME/DIV	Magnification Accuracy	Linearity	Conditions
0.5 sec/div – 0.2 usec/div	Within 3 %	Within 5 %	_____
0.1 usec/div	Within 5 %	Within 5 %	Except for the initial two peaks.
50 nsec/div	Within 7 %	Within 7 %	"
20 nsec/div	Within 10 %	Within 10 %	"
10 nsec/div	uncalibrated	uncalibrated	_____

The sweep time over 0.1 μ sec is measured by 100 MHz sine wave.

MAXIMUM SWEEP TIME

2 nsec/div (at uncalibrated range, 1 nsec/div)

DELAY TIME

A continuously variable sweep delay from 1 μ sec to 5 sec is available and by using the A VARIABLE control, the delay can be extended up to approximately 12.5 sec.

DELAY JITTER

When the display is magnified by the delayed sweep, jitter is caused on the display. The amount of jitter is

determined by the ratio of A and B TIME/DIV and DELAY TIME MULTI dial range, and is 1/20000.

SINGLE SWEEP

Two single sweep modes, normal and delayed, are available.

TRIGGERING

Individual triggering is provided for each sweep; A triggering for the A sweep and B triggering for the B sweep.

A TRIGGERING

TYPE OF TRIGGER SIGNAL SOURCE

4 positions Internal (INT) - CH1, CH2
External (EXT, EXT ÷ 10)

SLOPE

+ Trigger (triggered by positive going slope of input signal)
– Trigger (triggered by negative going slope of input signal)

Table 1–6 Triggerable Frequency Range and Level of A Triggering

Coupling	Triggerable Frequency Range	Trigger Level		
		Internal Trigger (Display Amplitude) INT	External trigger (Voltage)	
			EXT	EXT ÷ 10
AC	30 Hz – 20 MHz	0.5 div	100 mVp-p	1.0 Vp-p
	20 MHz – 100 MHz	1.0 "	150 "	1.5 "
	100 MHz – 200 MHz	3.0 "	200 "	2.0 "
AC LF REJ	50 kHz – 20 MHz	0.5 "	100 "	1.0 "
	20 MHz – 100 MHz	1.0 "	150 "	1.5 "
	100 MHz – 200 MHz	3.0 "	200 "	2.0 "
AC HF REJ	30 Hz – 10 kHz	0.5 "	100 "	1.0 "
DC	DC – 20 MHz	0.5 "	100 "	1.0 "
	20 MHz – 100 MHz	1.0 "	150 "	1.5 "
	100 MHz – 200 MHz	3.0 "	200 "	2.0 "

(Caution) In the AUTO triggering mode, the sweep is not triggered by signals lower than 50 Hz, even if the COUPLING switch is in the DC position.

TRIGGER INPUT COUPLING MODE

4 Modes: AC, LF REJ, HF REJ and DC
Triggerable frequency range of each mode is shown in Table 1-6.

TRIGGERING FREQUENCY RANGE AND TRIGGER LEVEL

Refer to Table 1-6.

INPUT IMPEDANCE OF EXTERNAL TRIGGER INPUT CONNECTOR (TRIG INPUT)

1MΩ shunted by about 18 pF

AUTO AND NORMAL TRIGGER MODE

The MODE switch is used for selecting Auto and Normal triggering mode for A triggering, and (PULL TRIG) LEVEL (push-pull) switch for B triggering. In the Auto mode, the sweep circuit will not be triggered by signals below 50 Hz even if the COUPLING switch is set in the DC position. When a trigger signal is not present, the sweep will free-run. In the triggered mode, the input signal is triggered from DC. When the trigger signal is not present, a spot will appear on the CRT.

B TRIGGERING

TYPE OF TRIGGER SIGNAL SOURCE

4 positions Internal (INT) - CH1, CH2
External (EXT, EXT ÷ 10)

Table 1-7 Triggerable Frequency Range and Level of B Triggering

Coupling	Triggerable Frequency Range	Trigger Level		
		Internal Trigger (Display Amplitude) INT	External trigger (Voltage)	
			EXT	EXT ÷ 10
AC	30 Hz - 20 MHz	0.5 div	100 mVp-p	1.0 Vp-p
	20 MHz - 100 MHz	2.0 "	200 "	2.0 "
AC LF REJ	50 kHz - 20 MHz	0.5 "	100 "	1.0 "
	20 MHz - 100 MHz	2.0 "	200 "	2.0 "
AC HF REJ	30 Hz - 10 kHz	0.5 "	100 "	1.0 "
DC	DC - 20 MHz	0.5 "	100 "	1.0 "
	20 MHz - 100 MHz	2.0 "	200 "	2.0 "

The maximum input voltage to TRIG INPUT for A and B triggering is 500 V. (DC + AC peak or AC peak-to-peak)

SLOPE

- + (Triggered by positive going slope of input signal)
- (Triggered by negative going slope of input signal)

TRIGGER INPUT COUPLING MODE

4 Modes: AC, LF REJ, HF REJ and DC

Triggerable frequency range of each mode is shown in Table 1—7.

TRIGGERING FREQUENCY RANGE AND TRIGGER LEVEL

Refer to Table 1—7;

INPUT IMPEDANCE OF EXTERNAL TRIGGER INPUT CONNECTOR (TRIG INPUT)

1M Ω shunted by about 18 pF

CALIBRATOR

CALIBRATION VOLTAGE

The calibration voltage is obtained from the CAL OUT connector. Characteristics of this output are shown in Table 1—8.

Table 1—8

Item	Characteristics and Accuracy	
Voltage	Square wave	.02 Vp-p — 2 Vp-p Three ranges: Within ± 1 %
Frequency	1 kHz	Within ± 1 %
Symmetry	Within 49 : 51	
Square wave Characteristics	Rise time	Within 0.5 μ sec
	Fall time	Within 0.5 μ sec

CATHODE RAY TUBE CIRCUIT

CATHODE RAY TUBE

Type	D10-200GH/07, 4-inch rectangular type, parallax-free, internal graticule.
Effective Display Area	6 div (vertical) x 10 div (horizontal) (1 div = 8 mm)

ACCELERATION VOLTAGE

Approximately 15 kV

EXTERNAL INTENSITY MODULATION

Minimum intensity modulation voltage	5 Vp-p
Input impedance (Z AXIS INPUT)	approx. 30 k Ω Shunted by 3pF,
Frequency characteristics	DC — 50 MHz

POWER REQUIREMENTS

OPERATING RANGE

By selecting an appropriate switch position (200V ~ 230V) located on the lower right of the rear panel, this instrument can be used with the line voltages (commercial power sources) shown in Table 1—9. (This model can be easily modified for 100V use when requested.)

Table 1—9

Source Voltage	Switch Position	Applicable Line Voltage Range
100 V	LOW (100 V)	90 — 110 V
	HIGH (115 V)	105 — 126 V
200 V	LOW (200 V)	180 — 220 V
	HIGH (230 V)	207 — 253 V

LINE FREQUENCY

50/60 Hz

POWER CONSUMPTION

Approximately 75W (at 200V, line voltage)

ENVIRONMENTAL CONDITIONS

OPERATING TEMPERATURE RANGE

The environmental temperature range for normal opera-

tion of this instrument is from -10°C to + 50°C .

OPERATING HUMIDITY RANGE
(RELATIVE HUMIDITY)

This instrument operates normally with a relative humidity from 20 to 90 % at 40°C.

VIBRATION

This instrument will operate normally after a vibration test wherein the instrument is subjected to vibrations with an amplitude of 1.5 mm (peak-to-peak) at 1000 cycles per minute along each of the three major axes for one hour.

SHOCK

Operation of this instrument is normal after three shock tests for each major axis. This can be performed by raising one edge of the equipment 5 cm above a rigid test bed (or, an incline of 30 degrees at maximum) and releasing it.

CONSTRUCTION

EXTERNAL DIMENSIONS

Approximately 270 mm W x 156 mm H x 406 mm L

WEIGHT

Approximately 12.5 kg

COLOR

Front panel
Cabinet

White aluminum
Leather tone Munsell 5GY5/0.5

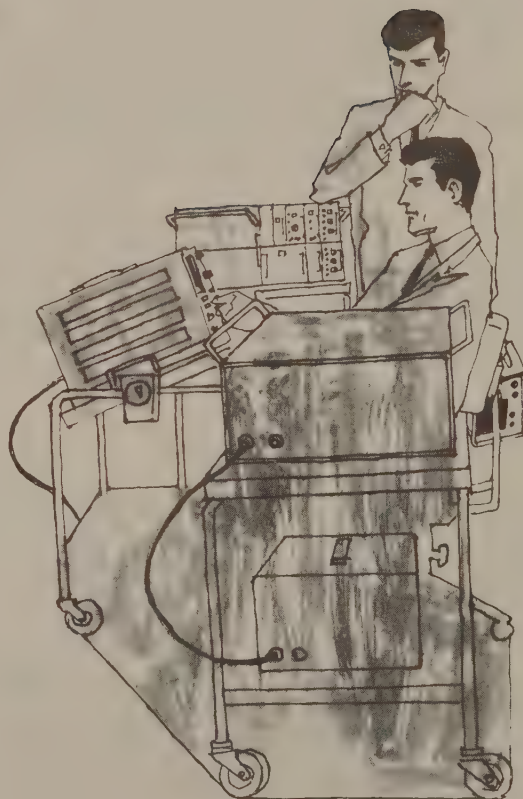
CHAPTER 2 OPERATION

For effective use of this instrument, the operator must be familiar with the function and operation.

In this chapter, handling precautions and functions of panel controls will be described. Practical operating procedures will be described. Practical operating procedures will be described in the later half of this chapter.

When this instrument is to be used immediately, the first part of this chapter may be bypassed and the section "Operating Procedure" on page 2-12 referred to.

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CARRYING AND USE

CARRYING AND PANEL COVER

As seen in Fig. 2-1, there are two different ways of carrying this instrument. When the instrument is to be carried over a long distance, the method shown in Fig. 2-1 (a) should be followed. The method shown in Fig. 2-1 (b) is suitable for carrying it for a medium and short

Figure 2-1 Carrying of the instrument



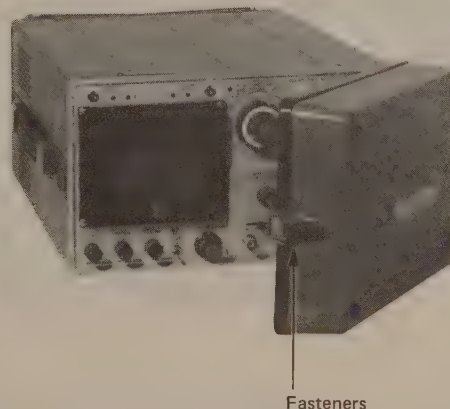
distance.

Exercise care in protecting the instrument from excessive shocks and vibrations when carrying. Special care should be taken for the front panel when carrying the instrument in the shoulder bag.

A panel cover (Fig. 2-2) is provided to protect the front panel. Be sure to install the cover over the front panel before transporting the instrument or when the instrument is not used for a long period of time.

Figure 2-2 Panel cover

For removing the panel cover, unlock the two spring fasteners and pull the cover forward.

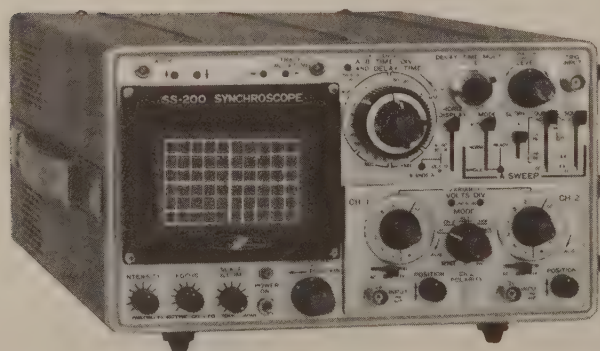


OPERATING POSITIONS

This equipment can be operated in the four positions shown in Fig. 2-3 (a) to (d), depending on the situation. When it is used in the vertical position, be careful extremely so as not to apply excessive pulling force on the probe.

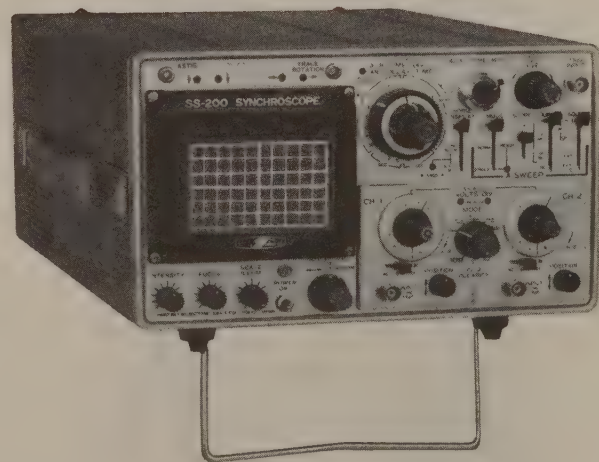
Fig. 2-3

When the instrument is positioned at the same height as that of user's eyes.



(a)

When the instrument is positioned at a lower level than that of user's eyes.



(b)

When the operating position is changed, the vertical position of the trace on the CRT screen may shift slightly, however, this is not abnormal. The trace will return to its original position in approximately 1 minute. The instrument is provided with a fan. Be careful to assure good ventilation when this instrument is used.

When the instrument is positioned at a higher level than user's eyes,



(c)

When the instrument placed directly on the floor, pull the stands outside.
After using, push the Push-Button on the rear panel, then the stands are returned inside.



(d)

FEATURES OF FILTER AND REPLACEMENT

A mesh filter is used in this synchroscope, and a polarized filter is provided as an accessory. These filters are used for higher contrast of the trace, to facilitate observation, and to absorb the external light reflected from the phosphor screen. Features of the individual filters are indicated in Table 2-1, and it is recommended that a suitable filter be selected in accordance with the situations.

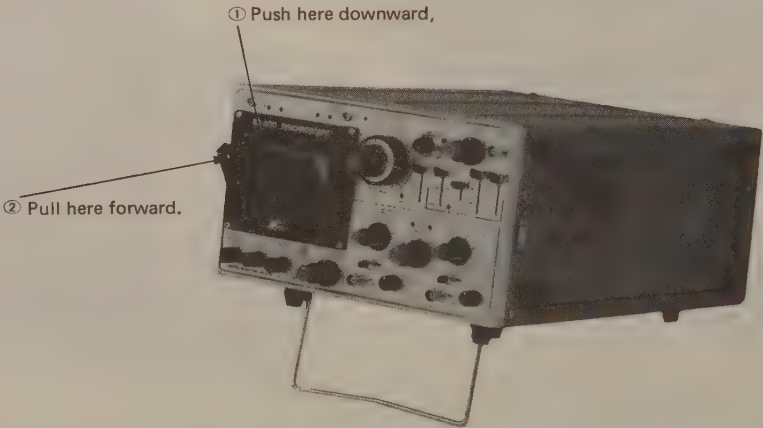
When photographing a display, remove the filter to improve the definition as indicated in Fig. 2-4. Press the bottom edge of the filter, and the top edge of the filter

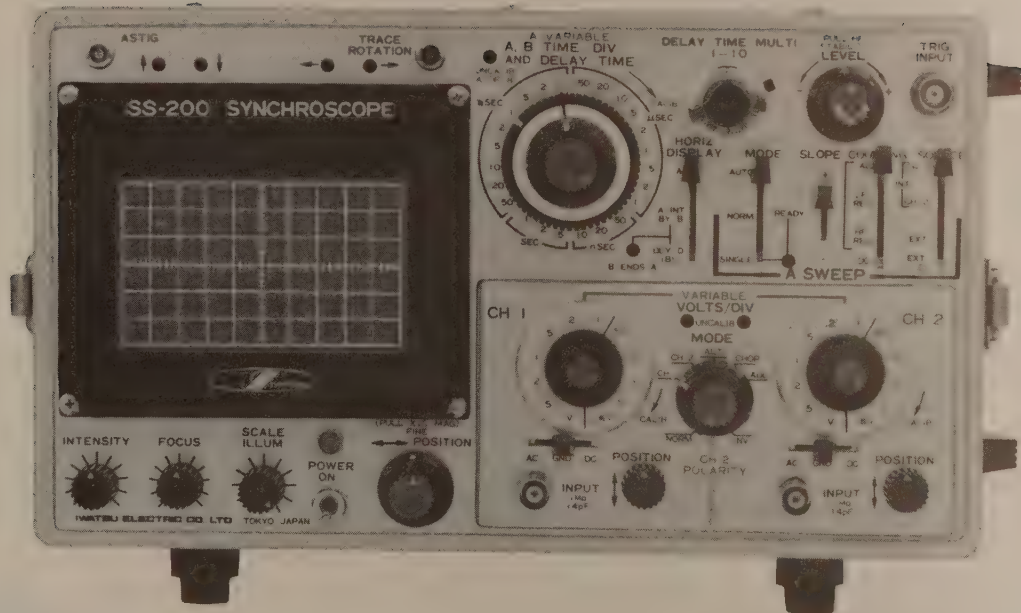
will be released and project. This filter is subject to damage and should therefore be handled carefully during removal or inspection.

Table 2-1

Mesh filter	Polarized filter
Surface reflection of light is eliminated since external light through the mesh can be completely absorbed. Sharpness of the trace focus is slightly deteriorated.	The external light diffusion is removed. However, the surface reflection remains. Good focusing can be obtained.

Figure 2-4 Removal of filter







DESCRIPTION OF PANEL CONTROLS

This section of the manual describes operating controls, switches and connectors on the front, right side and rear panels. For concentric controls, the slate gray markings on the panel indicate the slate gray control position, and the red markings indicate the position of the red control. Refer to Fig. 2–5.

FRONT PANEL

———— POWER SUPPLY AND CRT CIRCUIT ————

POWER ON (Small toggle switch)

Power line switch. Power is supplied to internal circuits when switched to ON position, and the pilot lamp lights.

SCALE ILLUM

Controls illumination of the internal graticule. Lamps are intensified by clockwise rotation of this control, and go off at extreme counterclockwise position.

INTENSITY

Controls brightness of the trace or spot. The trace is intensified by clockwise rotation of this control, and de-intensified by counterclockwise rotation.

FOCUS

A control to focus the trace or spot on the CRT.

ASTIG

A screwdriver adjust control used to improve focusing. When sharp focusing is not obtained by adjusting the FOCUS control, adjust the ASTIG control in conjunction with FOCUS.

TRACE ROTATION

A screwdriver adjust control used to position the trace on the horizontal scale on the CRT.

———— VERTICAL DEFLECTION SYSTEM ————

Corresponding controls and connectors for CH1 and CH2 function identically, therefore these will be described collectively, for CH1 only.

MODE (Slate gray control)

Determines operating mode of dual trace vertical axis amplifier. The following modes are available.

CH1

Selects CH1 amplifier only. In this position, the instrument operates as a single trace synchroscope.

CH2

Selects CH2 amplifier only. The instrument also operates as a single trace synchroscope.

ALT

Operation of CH1 and CH2 is alternately switched after each horizontal sweep. Simultaneous display of each signal becomes impossible at slow sweep speeds (below approx. 2 msec/div). The ALT mode is suitable for comparatively high frequency input signals. Simultaneous sweep measurement of two signals is impossible in the ALT mode. For photographing the dual trace display, depress the RESET button two times.

CHOP

Signals from CH1 and CH2 amplifiers are switched at a repetition rate of approximately 1 MHz, and are simultaneously displayed. In this mode, the signals are displayed as dotted lines, and signals may become inconvenient to observe at sweep speeds of approximately $10 \mu\text{sec/div}$ or more.

The CHOP mode operation is preferred for measuring comparatively low frequency signals.

ADD

CH1 and CH2 amplifiers operate simultaneously, and the algebraic sum or difference of these signals is displayed.

CH2 POLARITY (Red control)

A switch to select output polarity of CH2. In the NORM position, a normal output (in-phase with input) is obtained, and in the INV position, the polarity is reversed.

INPUT (Connector)

A BNC type connector to connect the signal to be measured. When the probe is used for measurements, its output is connected to this connector.

AC-GND-DC (Lever switch)

A switch to select the input coupling mode.

AC : ac coupling; rejects DC component of the input signal.

DC : direct coupling.

GND: grounds amplifier input (does not ground signal input). For checking ground (reference) level.

VOLTS/DIV (Slate gray control)

A switch to select a vertical deflection sensitivity from 5 mV/div to 5 V/div in ten steps. An appropriate position must be chosen for adequate display size.

When the VARIABLE control is turned fully clockwise (CALIB), the voltage per division of the graticule is that indicated by the position of the VOLTS/DIV switch.

VARIABLE (Red control)

A continuously variable control to attenuate the input signal. The maximum attenuation ratio of 1/2.5 (or more) is obtained at the fully counterclockwise position of this control. Therefore, continuous attenuation between steps of VOLTS/DIV switch is possible.

For quantitative measurement of input signal, the VARIABLE should be set to the CALIB position.

UNCALIB

An indicator which lights to indicate that the sweep time or delay time indicated by the VOLTS/DIV switch is not calibrated.

POSITION

A control to adjust the vertical position of the trace or spot. When this control is turned clockwise, the trace moves upward, and it moves down with counterclockwise rotation.

↑↓ (neon lamps)

A neon lamp which lights when the trace vertically shifts on the CRT, and indicates the direction. When the trace shifts out of the viewing area, use the POSITION control to return the trace to center.

———— HORIZONTAL DEFLECTION SYSTEM ————**HORIZ DISPLAY (Lever switch)**

Selects one of the following three horizontal deflection modes.

A

A mode used for ordinary waveform measurement. Horizontal trace is produced by a sawtooth wave generated in the A sweep generator. Sweep time is determined by the A TIME/DIV and A VARIABLE.

A INT BY B

For ease of delayed sweep observation [an optional portion of the input signal is magnified in the delayed sweep, and this function is described in the following item DLY'D (B)], the portion of the A sweep which is swept by the B sweep is intensified more than the normal A sweep. (Refer to "Operating Procedure, Delayed Sweep Operation" for details of this function.)

DLY'D (B)

In this mode, the sweep is delayed, and the intensified part of the display obtained above (A INT BY B) is magnified in the horizontal display area. (Refer to section "Operation, Delayed Sweep Operation" for details of this function.)

MODE (Lever switch)

This switch determines the operating mode of the A SWEEP circuit.

AUTO

The A SWEEP circuit is triggered in the Auto trigger mode. In this mode, the triggering mode automatically changes to free-running, when the frequency of trigger signal is below 50 Hz, when a trigger signal is not present, or when the LEVEL control is set to a point which exceeds the trigger point — a point on input signal waveform from which the trigger pulse is initiated.

The triggerable frequency range in this mode is from 50 Hz up to 200 MHz.

NORM

The A SWEEP circuit is triggered in the Normal trigger mode. In this mode, the sweep stops and only a spot appears when a trigger signal is not applied, the same thing occurs when the LEVEL control exceeds the signal level.

The triggerable frequency range is from DC to 200 MHz.

SINGLE

Single sweep operation is performed. The horizontal deflection circuit is swept only once. Single sweep operation is possible only at the A, A INT BY B, and DLY'D (B) positions of the HORIZ DISPLAY switch.

A, B TIME/DIV AND DELAY TIME (Slate gray control)

The larger slate gray control indicates the A TIME/DIV and DELAY TIME, and the upper smaller slate gray control indicates the B TIME/DIV.

The A TIME/DIV (DELAY TIME) control is used to select a sweep time from 10 nsec/div to .5 sec/div in 24 steps. The optimum position for an observation should be determined in accordance with the frequency and rise time (or fall time) of the input signal.

This switch also determines the delay time in delayed sweep operation.

When the A VARIABLE control is turned fully clockwise (CALIB position — UNCAL light goes off), the sweep time can be directly read from the indication of the TIME/DIV switch. The delay time can also be read directly by setting the A VARIABLE control to the extreme clockwise position and by multiplying the A TIME/DIV indication and the DELAY TIME MULTI indication.

The B TIME/DIV control is used to select a sweep time from 10 nsec/div to .5 sec/div in 24 steps. The sweep time can be read directly from the indication of B TIME/DIV when the B VARIABLE control (on the right side panel) is rotated fully clockwise (CALIB position — UNCALIB lamp goes off).

A VARIABLE (Red control)

Provides fine adjustment of A sweep time. By adjusting this control, the sweep time indicated by the A TIME/DIV switch can be extended by 2.5 times (or more). The sweep speed becomes slower with counterclockwise rotation of this control. For quantitative measurements, this control should be set to the CALIB position.

UNCALIB A OR B (Neon lamp)

A lamp which lights to indicate that the sweep time or delay time is not calibrated. The lamp lights in the following two cases and indicates that the A sweep or B sweep time uncalibrated.

- (1) When A VARIABLE control is in a position other than CALIB (fully clockwise).
- (2) When B VARIABLE control is in a position other than CALIB (fully clockwise).

B ENDS A (Neon lamp)

Lights to indicate that the delayed sweep intensity increases abnormally when HORIZ DISPLAY is in A INT BY B or DLY'D (B) position and the RESET button provided on the right side panel is depressed.

Normal brightness is obtained by pressing the RESET button again, and the indicator lamp goes off.

DELAY TIME MULTI 1—10 (Dial)

This control varies continuously the delay time, and the desired portion of the input signal can be magnified in the display area.

POSITION (Slate gray control)

Used to adjust the horizontal position of the trace or spot. Clockwise rotation of this control moves the trace to the right, and counterclockwise rotation shifts the trace to the left.

(PULL X 10 MAG)**FINE (Red control)**

Provides fine adjustment of horizontal positioning. As a push-pull switch, the sweep time can be magnified by 10 times by pulling it. Fine adjustment is possible with both push and pull operations, which are particularly effective for positioning of the magnified horizontal display.

← → (Neon lamps)

An indicator lamp which lights when the trace or spot shifts horizontally.

Lamp indicates the direction of trace shift.

A trace which has shifted out of the viewing area should be returned by the POSITION control.

TRIGGERING CIRCUIT

Switches and connectors in the trigger circuit are classified into those related to the A sweep (located in the right section of the front panel) and those for the B sweep (located in the B SWEEP section on the right side panel), however, the function of the corresponding controls in the two circuits is practically identical.

The following descriptions, therefore, are for the controls and connectors of the A sweep unless otherwise stated.

SOURCE (Lever switch)

Selects one of the following trigger signal sources. (Refer to "Operation, Proper Triggering" for details.)

CH1 (INT)

Sweep is internally triggered by the input signal fed to the CH1 INPUT connector.

CH2 (INT)

Sweep is internally triggered by the input signal fed to the CH2 INPUT connector.

EXT

Sweep is externally triggered. The input signal, or a signal of which the timing is an integral multiple of the input signal, must be connected to the TRIG INPUT connector (for both A and B sweep).

EXT ÷ 10

The external trigger signal is attenuated by 10:1 in this position. This is advantageous when the external trigger signal is excessively large and the proper triggering point cannot be obtained in the EXT mode.

TRIG INPUT (Connector)

A connector for connecting an external trigger signal.

COUPLING (Lever switch)

In order to ensure stable triggering, the external trigger must be coupled properly to the trigger circuit. (Refer to "Operating Procedure, Proper Triggering" for details).

AC

The trigger signal is AC coupled. Since the DC component of the trigger signal is blocked, influence of the DC voltage on the trigger signal is eliminated.

LF REJ

External trigger signal is connected to the trigger circuit through a high pass filter, and low frequency noise superimposed on the trigger signal, or low frequency components (below approximately 50 kHz) in the signal, are blocked.

HF REJ

External trigger signal is connected to the trigger circuit through a low pass filter. High frequency noise superimposed on high frequency trigger signals (above approximately 10 kHz) are blocked.

DC

The external trigger signal is coupled directly to the trigger circuit and the sweep can be triggered by a very low frequency, or DC.

SLOPE (Lever switch)

Selects slope of trigger signal which starts the sweep. Sweep can be triggered from negative (—) or positive (+) going portion of input signal.

LEVEL (Slate gray control)

Selects amplitude point on trigger signal at which sweep is triggered.

(PULL HF)**STABILITY (Red control)**

When the sweep is triggered by a signal higher than approximately 10 MHz, jitter may be present even with optimum adjustment of the LEVEL control. Use this control to push and turn when the signal jitter appear below approximately 100 MHz and to pull and turn when the signal jitter appear above approximately 100 MHz.

So this control eliminate these jitter.

RIGHT SIDE PANEL**B VARIABLE**

Provides continuous variation of B sweep time. By adjusting this control, the sweep time indicated by the A

TIME/DIV switch can be extended by 2.5 times (or more).

The sweep speed becomes slower with counterclockwise rotation of this control. For quantitative measurements, this control should be set to the CALIB position.

TRIGGER CIRCUIT

Refer to description for A triggering for the following items.

SLOPE
COUPLING

SOURCE
TRIG INPUT

(PULL TRIG) LEVEL

As a rotary control, the triggering point can be adjusted and as a push-pull switch, the AUTO or TRIGGER mode is selected.

CALIBRATOR**CAL**

Selects the calibration voltages.

CAL OUT

A connector to supply the calibration output voltage (frequency 1 kHz, within $\pm 1\%$) selected by the CAL.

OTHERS

CH2 OUT

An output connector to supply the input voltage of the CH2 of which amplitude is amplified by 5.

RESET

Selects the following two operations.

- (1) Single sweep. Similar to operation provided by AUTO and NORM triggering. Set the MODE switch to the SINGLE position. One sweep will occur for a trigger signal occurring after the RESET push-button is pushed. No further sweep will occur until the RESET push-button is pushed and another trigger signal is applied.
- (2) Increases the intensities of a delayed sweep display. For increasing brightness, set the HORIZ DISPLAY switch to A INT BY B or DLY'D (B) position and depress the RESET button. For de-intensifying for the previous brightness, press the button again.

GND

A ground terminal

REAR PANEL

200 V/230 V (or 100 V/115 V) SWITCH (Toggle switch)

A switch to select the applicable power source voltage.

In the low position, this instrument operates on a source voltage of $200\text{V} \pm 10\%$, and in the higher position, operates on $230\text{V} \pm 10\%$.

By a simple change of transformer connections, this instrument can be operated on $100\text{V} \pm 10\%$ (in the lower position) or $115\text{V} \pm 10\%$ (higher position).

FUSE HOLDER

A fuse holder containing a 1 Amp slow blow fuse. The slow blow fuse will blow in the event excessive current is drawn during operation but will not blow as a result of surge current when the POWER switch is turned ON.

Z AXIS INPUT

A connector for external intensity modulation.

OPERATING PROCEDURE

The proper operating procedures for this instrument will be described next. The best way to become familiar with the operation of this instrument is to apply various input signals and operate the controls. The internal circuits will not be damaged by manipulation of the panel controls and switches. However, the precautions described in the following item "Pre-start operation" should be observed.

PRE-START OPERATION

CHECK THE VOLTAGE OF THE POWER SOURCE

This instrument is designed to be used on the line voltages shown in Table 1—9. Set the LINE VOLTAGE switch to a position which coincides with the available line voltage. Operating this instrument on line voltages other than those listed in the table may cause trouble.

AMBIENT TEMPERATURE

The ambient temperature range for normal operation of this instrument is from -10°C to $+50^{\circ}\text{C}$. Avoid using this instrument in conditions exceeding this range.

DO NOT APPLY EXCESSIVE INPUT SIGNALS

The maximum allowable input voltage which can be applied to the CH1 or CH2 INPUT, and the probe tip is 500V (DC + AC peak, or AC peak to peak). Do not apply voltages exceeding this.

DO NOT LEAVE AN INTENSIFIED SPOT STATIONARY FOR LONG PERIODS

Excessive intensity of a spot or trace, especially when left in one place for a long period, may damage the phosphor on the CRT, or other related parts.

DO NOT APPLY EXCESSIVE FORCE ON THE SWITCHES OR CONTROLS

Faulty manipulation of switches and/or controls will not damage the internal circuits, but rough handling of these controls may damage them mechanically.

APPLYING POWER AND APPEARING A SWEEP

Now you are ready to proceed with actual operation.

TURN THE POWER ON, AND INTENSIFY SPOT

Turn the POWER switch OFF and connect the power cable to the line connector. Place the following controls in the positions indicated below.

INTENSITY	Fully clockwise
MODE	CH1
CH2 POLARITY	NORM
POSITION (Vertical)	Approximately center of range
HORIZ DISPLAY	A
A SWEEP MODE	NORM
POSITION (Horizontal)	Approximately center of range

Turn the POWER switch ON. The instrument is operational 15 seconds after it is turned on. Turn the POSITION control clockwise until the spot appears in the viewing area. The spot should be excessively bright. Turn the INTENSITY control counterclockwise until the desired intensity is obtained.

FOCUS THE SPOT

Adjust the vertical POSITION and horizontal POSITION alternately to move the spot to the center of the viewing area. (When an input signal is applied and displayed, the edges of the display may be slightly out of focus. Adjust the ASTIG and FOCUS for a sharp display throughout the entire viewing area.)

SWEEP

When the A SWEEP MODE switch is changed to the AUTO position, the sweep should start. The sweep may become somewhat unstable at the mid-position of the LEVEL control. This is not a defect and the sweep will be stabilized by turning the control slightly to the right or left.

The INTENSITY may have to be readjusted for adequate trace intensity. With the controls set as instructed above, the trace starts from the center of the CRT and sweeps to the right.

Turn the horizontal POSITION control counterclockwise to move the sweep start to the left edge of the graticule.

Turn the A TIME/DIV and A VARIABLE control and confirm that the sweep time varies in accordance with the controls.

APPLYING SIGNAL AND TRIGGER

CONNECT INPUT SIGNAL

The next step is a practical operation to display a waveform, using the calibration voltage (CAL) output as an input signal.

Connect the CAL OUT connector to the CH1 INPUT connector by using the coaxial cable (BB-500), and place the following controls in the positions indicated.

VOLTS/DIV (CH1)	10 mV
VARIABLE (CH1)	CALIB position
CAL	.02V

Change the AC-GND-DC switch to the DC position, and set the A TIME/DIV switch to the 2 mSEC position. We can obtain a 2 div in amplitude calibration squar-waveform

on the screen.

Rotate the LEVEL control in both directions. The LEVEL control's mark (▲) deviates from near the center (0 position), the waveform will not be triggered, but will free-run. The LEVEL control, therefore, should be placed at near midrange when observing the synchronized input signal.

Turn the VOLTS/DIV counterclockwise through its steps. The vertical amplitude should decrease in accordance with the steps. Confirm that the amplitude continuously decreases with counterclockwise rotation of the VARIABLE control. Return the VARIABLE control to the CALIB position, set the VOLTS/DIV switch to the VOLTS/DIV switch to the 1V/div position, and CAL switch to 2V position. The display amplitude should return to 2 div. Through these operations, the relationship among the input signal, VOLTS/CM switch, and the VARIABLE control should be obvious.

BEFORE TRIGGERING

Proper triggering is a key point in operating a synchroscope. In general, the following items must be predetermined prior to triggering the sweep.

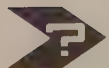
- (1) Selection of trigger signal
Internal trigger (INT) or external trigger (EXT), (EXT $\div$ 10)
- (2) Selection of trigger coupling mode
Selection of trigger coupling mode
AC, LF REJ, HF REJ, or DC mode
- (3) Selection of trigger polarity
Trigger on positive (+) or negative (—) going slope of input signal (Please refer to the item on "Proper

Triggering” for details.)

In this practice, the sweep will be triggered in the AC coupling mode and triggered by the positive going slope of the input signal connected to the INPUT connector for CH1. Therefore, the trigger controls must be set as follows:

SOURCE	CH1 (INT)
COUPLING	AC
SLOPE	+
MODE	AUTO
HORIZ DISPLAY	A

PROPER TRIGGERING

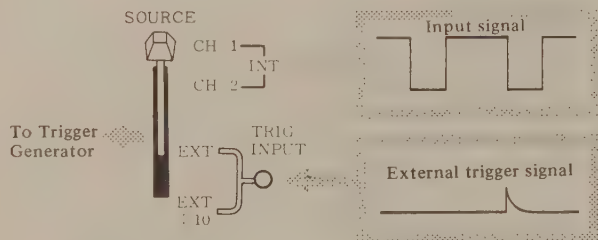


SOURCE SWITCH

For stable display of input signal waveforms, the sweep circuit must be triggered by the input signal, or a signal which has a certain (an integral multiple) relation to the input signal with regard to time, — this signal is called the trigger signal.

The triggering method wherein the SOURCE switch is set to the INT position and a portion of the input signal to be measured is internally (from the vertical deflection system) fed to the trigger generator, is called the internal trigger method (refer to Fig. 2–6). The external trigger method requires the connection of an external signal, having a direct or a certain time relationship to the input signal, as the triggering signal for the trigger generator. In this mode, the SOURCE switch must be set to the EXT or EXT $\div$ 10 position.

Figure 2–6 Selection of trigger signal with SOURCE switch



Internal trigger

In the internal trigger mode, the trigger signal is obtained internally from the vertical deflection system, and even an input signal of very low amplitude is appropriately amplified to an adequate level for triggering. Therefore, panel control operation for this mode is very simple, and the chance that the comparatively low input impedance of the external trigger circuit may load the trigger signal source is eliminated. From these advantages, it can be seen that internal triggering is generally convenient for measurement.

External trigger

The shortcomings of external triggering are described under internal trigger operation, however, the external trigger operation still provides the following advantages.

First, the triggering circuit is not influenced by the vertical deflection system. For example, voltage level of the signal, which is fed to the trigger input in the internal trigger mode, varies when the position of the VOLTS/DIV switch is changed or the POSITION control is turned. These variations may necessitate readjustment of the LEVEL control every time the position of the VOLTS/DIV which is changed. Conversely, in the external trigger mode, the triggering is stable, once adjusted, regardless of variations in the vertical deflection system except in the cases where the external trigger signal also varies.

Second, when it is desired to start the sweep a certain period in advance or after a certain time delay to display a particular point on the waveform, and provided that an appropriate triggering signal is available, the external triggering mode facilitates stable observation of the particular point.

When the SOURCE switch is set to the EXT position,

PROPER TRIGGERING

and the amplitude of the external trigger signal is excessively large, proper adjustment of the trigger level with the LEVEL control may be impossible. In these cases, trigger adjustment is facilitated by changing the SOURCE switch to the EXT $\div 10$ position which attenuates the trigger signal by 10:1.

CORRECT USE OF CH1 AND CH2

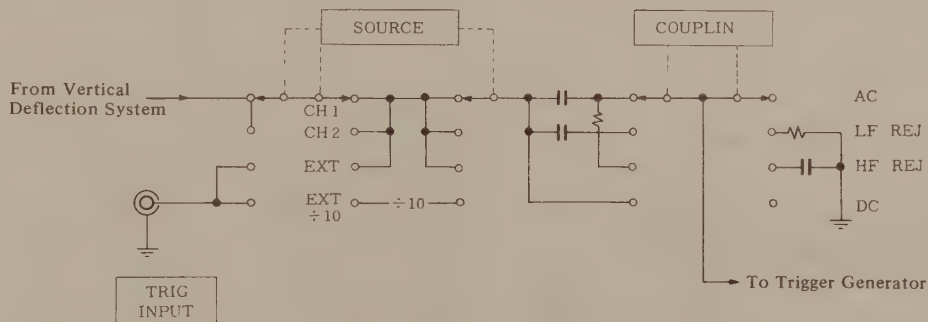
CH1 and CH2 positions are provided for selecting the internal triggering signal. When the SOURCE switch is set to the CH1 position, a portion of the signal applied to the CH1 INPUT connector is fed to the trigger circuit; similarly, when set to the CH2 position, a portion of the signal applied to the CH2 INPUT connector is fed to the trigger circuit. If two signals of the same frequency are being measured by CH1 and CH2, the TRIGGER switch should be set to the channel having the higher input level

and lesser superimposed noise. When the frequency of the input signals fed to the two channels is different, the sweep circuit should be triggered by the channel having the lower frequency. Otherwise the lower frequency signal will not be displayed.

USE PROPER COUPLING

The COUPLING switch is to select the coupling mode of the trigger signal and the trigger circuit. Four coupling modes, AC, LF REJ, HF REJ, and DC, are available. In these modes, the trigger signal and the trigger input are connected by a capacitor (AC), a high pass filter (LF REJ), a low pass filter (HF REJ), and directly (DC). The switch facilitates the selection of a suitable coupling method to provide stable triggering in accordance with the type of trigger signal (DC, AC waveform, AC waveform superimposed on DC, and low or high frequency noise on a waveform).

Figure 2-7 Connection of SOURCE and COUPLING



PROPER TRIGGERING ?

AC

As shown in Fig. 2-7, the trigger signal is connected to the trigger circuit through capacitor coupling. The DC component in the trigger signal is blocked and only the AC component is used for triggering. This ensures stable triggering by eliminating the influence to the DC component. The AC coupling is convenient for conventional measurement purposes, however, triggering sensitivity decreases at low frequencies (below 30 Hz) and triggering becomes less stable.

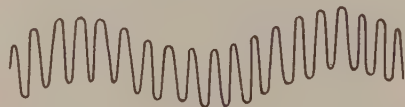
LF REJ

In this position, the trigger signal is fed to the trigger circuit through a high pass filter which blocks low frequencies (below approximately 50 kHz) or low frequency noise components superimposed on the trigger signal. Thus only the high frequency trigger signal triggers the sweep circuit. This mode is used to provided stable triggering when measuring signals containing low frequency noise components like that shown in Fig. 2-5.

HF REJ

In this position, the trigger signal is fed to the trigger

Figure 2-8 High pass filter in the LF REJ position

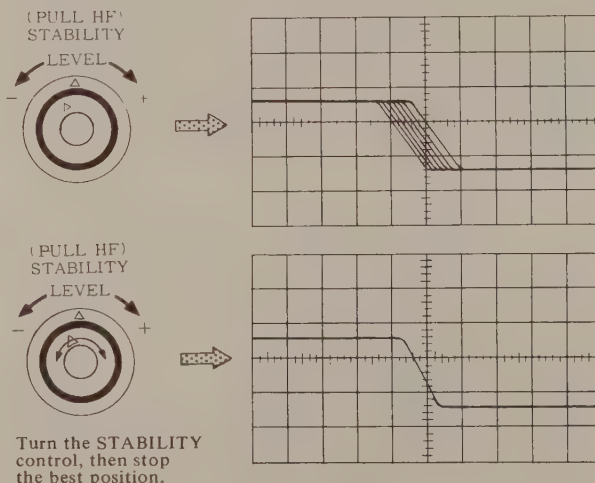


circuit through a low-pass filter, as shown in Fig. 2-7. Contrary to the LF REJ position, high frequency signals (above approximately 10 kHz), or high frequency noise superimposed on the trigger signal, are bypassed. This coupling mode is convenient when using a trigger signal containing high frequency noise.

DC

As shown in Fig. 2-7, the trigger signal is connected directly to the trigger circuit in this position which enables

Figure 2-9



PROPER TRIGGERING



triggering from a varying DC signal. If an external trigger signal superimposed on a DC voltage is fed to the trigger input in the DC coupling mode, and the DC level exceeds the control range of the LEVEL control, the trigger signal cannot trigger the sweep circuit. AC coupling must be used in this case.

ELIMINATING JITTER WITH (PULL HF) STABILITY CONTROL

When the sweep is triggered by a signal higher than

approx. 10 MHz, jitter may remain in the display even if the trigger LEVEL control is set to the optimum point. This jitter can be eliminated by adjusting the (PULL HF) STABILITY control. (See Fig. 2-9). When the jitter appear above approximately 100 MHz, use this control to pull and turning.

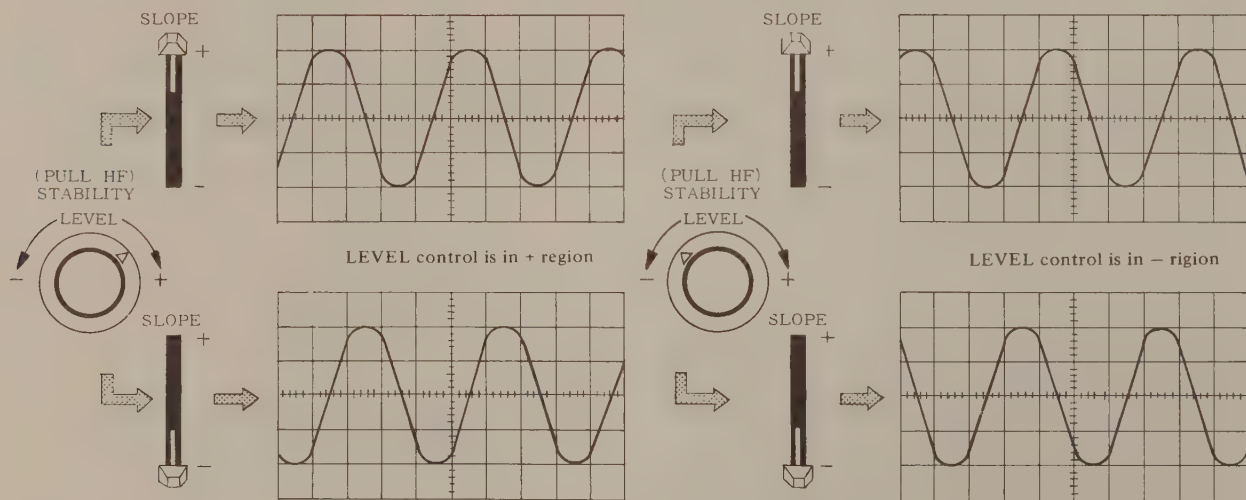
The jitter may cause a double or triple display of an input signal at comparatively low frequencies of the trigger signal and synchronization will be lost at high frequencies of the trigger signal and synchronization will be lost at high frequencies of the same.

TRIGGERING METHOD (AUTO TRIGGER)

The preceding control settings enable triggering by adjusting only the LEVEL (A) control. Turn the LEVEL (A) control slowly; the display should be triggered stably at approximately the mid-position of the control. Vary the SLOPE switch and adjust the LEVEL control as shown in Fig. 2-10. The relationship between these controls and the

display will be obvious. Fig. 2-10 shows an example of a sine wave, but the triggering point can be selected in the same manner for a square wave. A high sweep speed which provides a magnified display of the leading or trailing edge of the trigger point. The variable range of the trigger point is from 5 to 95% of the signal amplitude. (for an internally triggered sine wave of approx. 1 kHz with a vertical amplitude of 6 div on the graticule —

Figure 2-10 Relationship between SLOPE and LEVEL



the triggering range in the external trigger mode differs from the external trigger signal level.)

Turn the CH1 VOLTS/DIV switch counterclockwise to reduce the display amplitude by approximately 0.2 div. This decrease of display amplitude decreases the trigger signal level, and triggering may be lost and the display may start free-running. Adjust the LEVEL control again until the display is stable.

In this auto trigger mode, the display will free-run when the triggering signal is not present, or when the LEVEL control is not set at the triggering point. Therefore, when a free-running sweep is desirable, for example, to confirm the vertical position of ground (which is the reference of the vertical display), the AUTO position of the SWEEP mode is advantageous. It should be noted that the display will not be triggered in the AUTO mode by input trigger signals lower than 50 Hz. The TRIGGERED mode should be used for triggering such low frequency signals.

TRIGGERING METHOD (NORMAL TRIGGER)

When the A SWEEP MODE switch is placed in the NORM position, the NORMAL trigger is used for triggering the sweep. The LEVEL control must be adjusted similarly in this mode.

In this mode, however, when the trigger signal is not present, or the position of the LEVEL control exceeds the triggering point, the sweep stops, and the display becomes a spot awaiting triggering (the spot may not be visible unless it is intensified by adjusting the INTENSITY control).

The preceding triggering operations are based on the

internal triggering mode, however, these operations are identical for LINE or EXTERNAL triggering, except the operation for the input trigger signal source.

DUAL TRACE OPERATION AND MEASUREMENT OF SUM OR DIFFERENCE OF TWO SIGNALS

DUAL TRACE OPERATION

First, set the POSITION controls for CH1 and CH2 at mid-range and place the MODE switch in the ALT position. CH1 and CH2 traces will appear. Set CH1 and CH2 VOLTS/DIV to .1 and CAL to .2 V range and connect CAL OUT to the CH1 and CH2 INPUT connectors with the coaxial cable.

When the A TIME/DIV switch is turned counterclockwise, the CH1 and CH2 outputs will be displayed alternately and simultaneous observation of the two displays becomes impossible. Dual trace measurement of low frequency signals which require sweep speeds of less than 2 msec/div should be carried out in the CHOP mode as described below.

When the MODE switch is changed to the CHOP position, dual trace measurement at slow sweep speeds is possible. Contrary to the ALT mode, the CHOP mode is inconvenient for observation at sweep speeds above 10 μ sec/div as the waveforms will be displayed as dotted lines. Dual trace measurement of high frequency signals which require sweep speeds higher than 5 μ sec/cm or dual trace measurement of fast rise (or fall) time signals should be performed in the ALT mode.

When dual trace measurement of different frequency signals (these signals must have a direct time relationship) is required, the TRIGGER switch must be set properly as previously described in "Proper Triggering". More stable triggering will be obtained in the CHOP mode by setting the COUPLING switch in the HF REJ position.

SUM OR DIFFERENCE OF TWO SIGNALS

When the CH2 POLARITY switch is changed to the NORM position, and the MODE switch placed in the ADD position, the sum or difference of the CH1 and CH2 signals will be displayed. When the CH2 POLARITY switch is changed to the INV position, the polarity of the CH2 signal is inverted and added to the CH1 signal. The difference between the two signals, or $CH1 + (-CH2)$, is displayed.

In the ADD position, the vertical position of the resultant waveform can be varied by either POSITION control.

CASCADE CONNECTION

By cascading the two amplifiers, the vertical deflection sensitivity can be increased to 1 mV/div.

The cascade connection will be described, using the sine wave of 5 mVp-p. Connect the input signal to the CH2 INPUT connector and place the following controls in the positions indicated.

MODE	CH2
SOURCE	CH2
VOLTS/DIV (CH1, CH2)	5mV

VARIABLE (CH1, CH2) CALIB position

Synchronize the sweep properly. The vertical amplitude of the display should be 1 cm, which is the normal deflection sensitivity.

Connect the CH1 INPUT to the CH2 OUTPUT with the BB-500 cable provided. Change the MODE switch to CH1 position. The vertical amplitude of the display will become 5 div, and the vertical deflection sensitivity is now 1 mV/div.

In the cascade connection, noise increases to some extent resulting in a noisy trace (rated maximum trace width is 0.3 div. or less). Triggering may become slightly unstable, but can be stabilized by setting the COUPLING switch to the HF REJ position.

SWEEP MAGNIFICATION

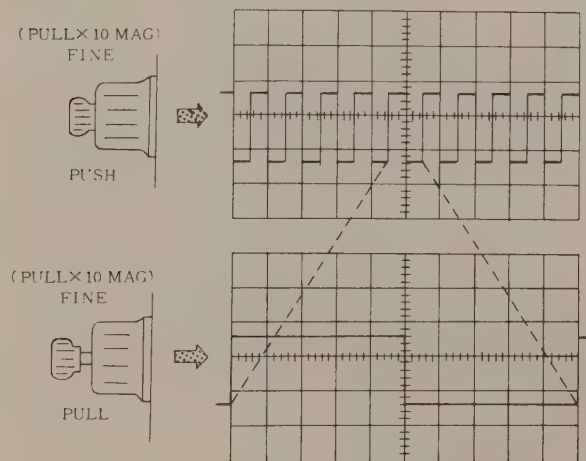
When a magnified display, with regard to time, of a particular part of a waveform is desired, the sweep speed may be increased. However, magnification by increasing sweep speed may drive the desired part out of the viewing area, unless the part is very close to the starting point of the sweep.

By pulling the (PULL x 10 MAG) FINE switch, the center portion of the display is magnified by 10 times, as shown in Fig. 2-11. The trace length in the viewing area is approximately 10 div, however, the unmagnified trace is now extended by 100 div. The entire trace can be observed by rotating the POSITION and FINE controls.

When magnified, the sweep speed is 1/10 of the value indicated on the A, B TIME/DIV switches. The maximum sweep speed of 10 nsec/div for an unmagnified trace, becomes $10 \text{ nsec/div} \times 1/10 = 1 \text{ nsec/div}$. (Uncalibrated).

Magnification of the sweep with the MAG switch is advantageous to increase the maximum sweep speed, but it reduces sweep intensity and may cause confusion in calculating the time relation of the displayed waveform (the multiplication by 1/10 may be overlooked). It may be

Figure 2-11 Sweep magnification by MAG switch



advisable not to use the magnified sweep except for a particular point on the waveform which is a considerable distance from the starting point of the sweep.

DELAYED SWEEP OPERATION

Although sweep magnification with the MAG switch is simple to operate and magnifies the rated TIME/DIV by exactly 10, its magnification is limited in value.

Magnification of the display by the delayed sweep can extend the magnification factor up to a value determined by a product of the A and B sweep times. This magnification factor, however, is limited by the frequency of the given input signal. In other words, when the input signal requires that the A TIME/DIV switch be set to the maximum speed, or 10 nsec/div, no further magnification is possible. Magnification with the delayed sweep is advantageous in magnifying an optional portion of a comparatively low frequency signal.

The delayed sweep is classified into the non-triggered and triggered modes.

NON-TRIGGERED DELAY SWEEP

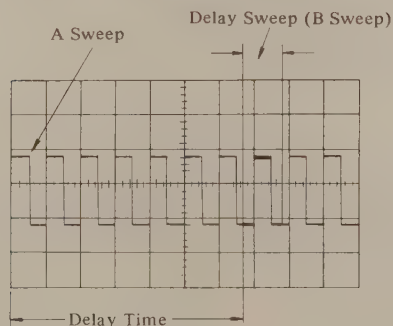
In the previous operation, various controls have been set to various positions. Now, for ease of delayed sweep operation, the following rearrangement of control settings is required.

MODE	CH1
VOLTS/DIV (CH1)	10 mV
VARIABLE (CH1)	CALIB
CAL	.02 V

HORIZ DISPLAY	A
MODE	AUTO or NORM
A TIME/DIV	1 mSEC
B TIME/DIV	.1 mSEC
LEVEL (B)	PUSH AUTO, mid-range
SOURCE (A)	CH1 — INT —
COUPLING (A)	AC
SLOPE (A)	+
INTENSITY	Moderate spot brightness

Connect the CAL OUT connector to the CH1 INPUT connector, with the BB-500 coaxial cable, and place the HORIZ DISPLAY to A INT BY B position. Turn the locking lever of the DELAY TIME MULTI to the left to release the dial, and slowly turn the dial clockwise. A portion of the display (delayed sweep part) will

Figure 2-12 Non-triggered delay sweep



be intensified, as shown in Fig. 2-12, and this intensified part will move toward the right with rotation of the dial. Any desired part of the A sweep display can be magnified in this manner.

The width of the delayed sweep part is determined by the setting of the B TIME/DIV switch and the B BARI-ABLE control (located on the right side panel).

Place the HORIZ DISPLAY switch in the DLY'D (B) position. The delayed sweep portion will be magnified to the full width of the viewing area, as shown in Fig. 2-13.

The magnification ratio is determined by the ratio of the A sweep time to the B sweep time. The displayed waveform can be moved horizontally by rotating the DELAY TIME MULTI dial. This dial allows any desired portion of a displayed waveform to be magnified and shifted. The delay time is determined by multiplying the readings of the A TIME/DIV value x DELAY TIME MULTI value (for direct calibrated readings, set the A VARIABLE control to the CALIB position).

Change the B TIME/DIV switch to the .2 μ sec range, and turn the DELAY TIME MULTI dial slowly until the leading or trailing edge of a square wave is displayed.

Delay jitter (unstable horizontal trace) will appear as shown in Fig. 2-14 and accurate evaluation of the leading or trailing edge will be difficult. This delay jitter restricts the upper limit of magnification. The magnification ratio however, can be increased by using the following triggered delay method.

TRIGGERED DELAY SWEEP

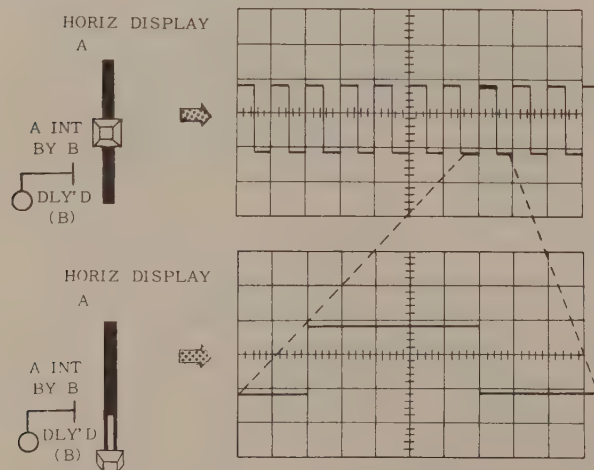
Change the control settings as follows.

A TIME/DIV 1 mSEC

B TIME/DIV .1 mSEC
 LEVEL (B) Pull TRIG, mid-range
 SOURCE (B) CH1 - INT -
 COUPLING (B) AC
 SLOPE (B) +

Turn the DELAY TIME MULTI dial more than one turn clockwise, and set the LEVEL (B) control to its mid-position. The delayed sweep part (intensified) will be triggered at the start of the A sweep. When the DELAY TIME MULTI dial is turned clockwise, the delayed sweep

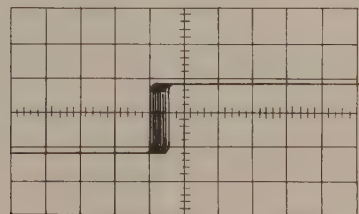
Figure 2-13 Non-triggered delayed sweep magnification



part will jump sequentially from one square wave to the next. Change the SLOPE (B) switch to the negative (−) position. The delayed sweep part will now be triggered at the trailing edge of the A sweep waveform. The width of the delayed sweep part is also determined by the B TIME/DIV switch and the B VARIABLE control.

Change the HORIZ DISPLAY switch to the DLY'D (B) position, to magnify the delayed sweep part to the full width of the display as shown in Fig. 2-16. The magnification ratio is determined by the ratio of A sweep time and B sweep time. Change the B TIME/DIV switch to the .2 msec position. Delay jitter should not appear. Therefore, a higher magnification ratio can be obtained in this mode compared to that of the non-triggered mode. The magnified waveform does not move when the DELAY TIME MULTI dial is rotated. In this method, the displayed waveform is a part of the delayed sweep portion, selected by A INT BY B and intensified.

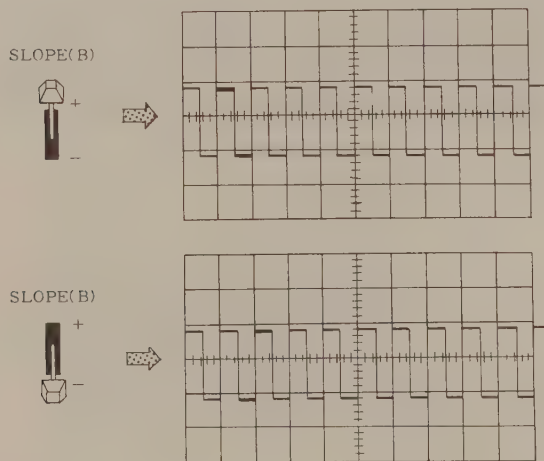
Figure 2-14 Delayed jitter



SINGLE SWEEP OPERATION

If a normal repetitive sweep is employed for observing a discharge waveform, chattering of relay contacts or other transient phenomena, the displayed waveform will appear to be out of sync as shown in Fig. 2-17. In such cases, the single sweep mode, by which the signal is swept only once, will display a correct waveform. Since the display is

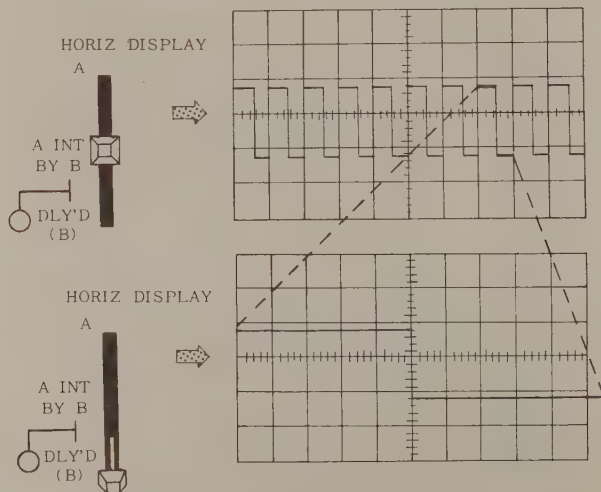
Figure 2-15 Triggered



not repeated, the waveform is normally recorded by taking a photograph.

The single sweep operation will be explained by using the calibration signal as the input signal. Connect the calibration voltage to the INPUT connector and set the controls as follows.

HORIZ DISPLAY A
MODE NORM

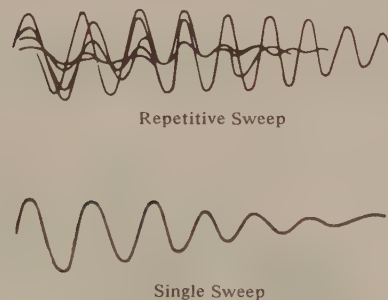
Figure 2-16 Triggered delay sweep magnification
[SLOPE (B) - + -]

VOLTS/DIV	Suitable position for adequate amplitude
A TIME/DIV	Any position for appropriate display
LEVEL	Center position

Adjust the triggering for a stable display and then change the MODE switch to the SINGLE position. Push the RESET button located on the right side panel, then the waveform will be displayed only once.

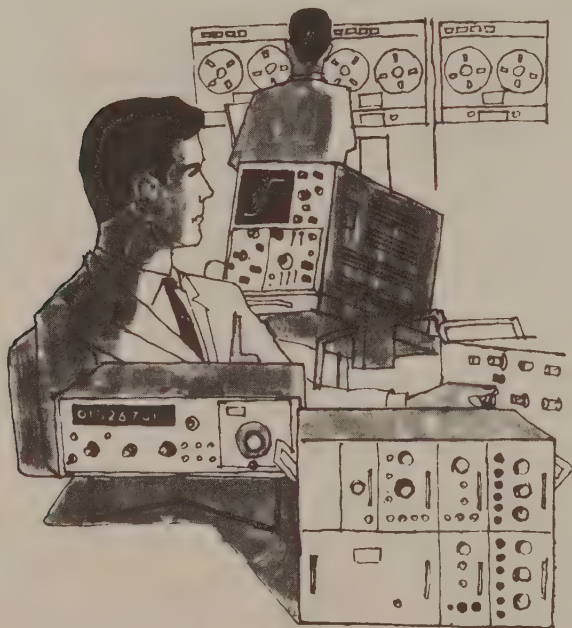
Remove the coaxial cable from the INPUT connector, and push the RESET button. The circuit is now reset and in a waiting condition (to actuate a single sweep when a trigger signal is applied), and the READY lamp lights to indicate this status. By connecting the calibration signal to the input, a single sweep is actuated. The waiting condition may not be obtained when the LEVEL control is close to its mid-position. In this case, adjust the LEVEL control slightly. Simultaneous observation of dual trace waveform is impossible in the single sweep made.

Figure 2-17 Repetitive sweep and single sweep



CHAPTER 3 MEASUREMENT

Various measurement procedures and their applications will be described in this chapter. Refer to chapters 1 and 2 for technical characteristics and basic operating procedures of this instrument.



CONNECTION OF INPUT SIGNAL	3- 1
PROPER USE OF PROBE	3- 4
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CONNECTION OF INPUT SIGNAL

The input circuit of this instrument, viewed from the INPUT connector, is composed of $1\text{ M}\Omega$ of resistance and 14 pF or parallel capacitance. When the accessory probe (type 1020) is used, the resistance increases to $10\text{ M}\Omega$ and the capacitance decreases to 10 pF , thus reducing the influence of the synchroscope on the circuit to be measured.

The signal to be observed may be connected to this equipment with conventional insulated wire, shielded cable, probe, or coaxial cable. The type of cable should be selected in accordance with the following conditions.

Output impedance of signal source

Amplitude and frequency of signal

Presence of external noise

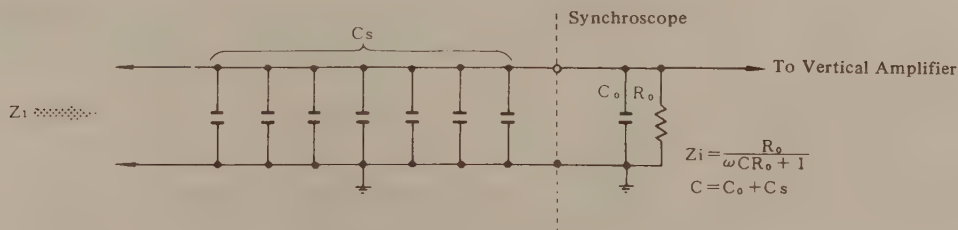
Distance between equipment and signal source

The preferable connection methods, classified in accordance with the type of input signal, are shown in Table 3-1.

Table 3-1

Type of Input Signal		Distance	Connection Method				
			Insulated wire	Shielded Cable	Probe	Coaxial Cable	Others
Low Frequency	Low Imp.	Short	○	○	○		
		Long		○		○	
	High Imp.	Short		○	○		
		Long		○			
High Frequency	Low Imp.	Short			○	○	
		Long				○	
	High Imp.	Short			○	○	
		Long					○

Figure 3-1 Input Impedance when Conventional Insulated Wire is used



The various connection methods will now be described further.

CONNECTING SIGNAL WITH CONVENTIONAL INSULATED WIRE

Direct readings can be obtained by connecting the INPUT connector to the circuit to be measured by using the insulated wire with both end insulation removed. The conductor can be connected to the INPUT connector by using the post adaptor (C) provided for this purpose. Using conventional insulated wire is simple and does not attenuate the signal to be measured.

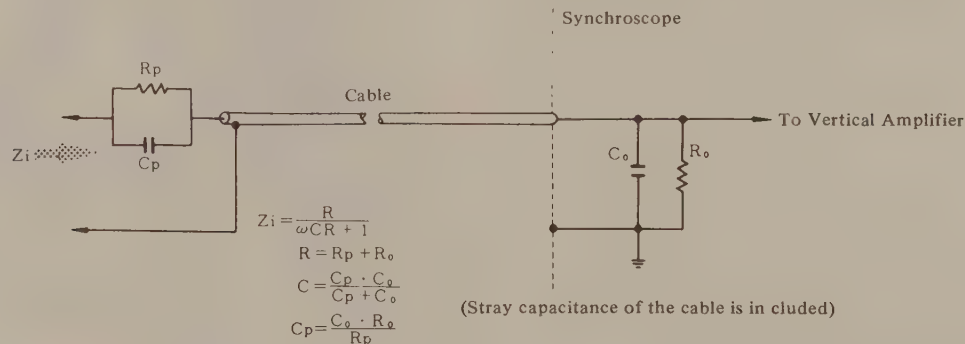
However, if there is a considerable distance between the

signal source and the synchroscope and/or a magnetic field is present in the vicinity of the measuring cable, noise may be induced and affect the measurement. The induction is apparent when the impedance of the circuit to be measured is high.

Stray capacitance between a conventional insulated wire and ground is also considerably large, and the input capacitance viewed from the circuit to be measured becomes: (stray capacitance C_s) + (instrument input capacitance C_o). The influence of this method on the circuit to be measured is greater than that of the probe (attenuation ratio 10:1).

For example, assuming the output impedance of the signal source to be $1\text{ k}\Omega$ with a frequency of 1 MHz and the input capacitance (stray capacitance of cable plus input

Figure 3-2 Input Impedance when a Probe is used



capacitance of instrument) to be 100 pF, the signal source output is shunted by an equivalent resistance of 1.6 k Ω . At lower frequencies, the influence of the stray capacitance decreases. For example, the equivalent resistance of the cable becomes 1.6 M Ω at 1 kHz and the influence on the signal source is considerably reduced.

The use of conventional wire is suitable mainly for low frequency and low impedance measurements.

USE OF SHIELDED CABLES

The use of shielded cable protects the signal from externally induced noise, however, the large capacitance of this cable (from 50 pF/m to 100 pF/m) limits the use of

shielded cable at high frequencies.

USE OF PROBE

The accessory probe 1020 (passive probe, as contrasted to the active probes such as source follower probe and cathode follower probe) attenuate the input signal by 1/10.

The influence of external induction is also eliminated since the input cable is shielded as shown in Fig. 3-2. In addition, the wide range attenuator composed of attenuating resistor R_p , parallel capacitance C_p , the instrument input resistor R_o and parallel capacitance C_o , ensures accuracy in measuring high impedance or high frequency signal sources.

Since the input capacitance of the probe viewed from the probe tip is approximately 10 pF (approximately 12 pF for probe 1021), the input impedance of the probe is approximately 15.6 k Ω (approximately 13 k Ω for probe 1021) with a frequency of 1 MHz and is comparatively higher than that in the previously described method.

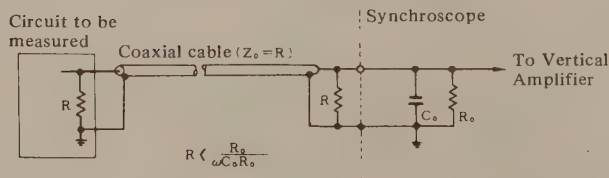
However, the probe has some disadvantages as the input signal is attenuated by 1/10 and the cable length is restricted.

USE OF COAXIAL CABLE

When the output impedance of a signal source is 50, 75, 93 or 125 Ω , the use of coaxial cable with the same characteristic impedance will enable high frequency signals to be coupled without attenuation.

It should be noted that the coaxial cable must be terminated properly at the instrument side distortion at high frequency signals.

Figure 3-3 Signal Coupling Using Coaxial Cable

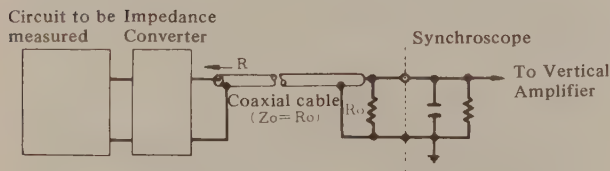


OTHER METHODS

For accurate measurement of remote signal sources having high frequency and high impedance, an impedance converter must be used to match the circuit impedance to that of the coaxial cable (75Ω , for example) which is used to connect the signal to the instrument. A transformer may be used for a narrow bandwidth measurement, but a source follower or similar circuit is preferred for wide band measurements. (Refer to Fig. 3-4.)

When the output level from the measured circuit is high, the input signal to the vertical amplifier may be voltage-divided by a divider whose output impedance is matched to the coaxial cable impedance, as shown in Fig. 3-5.

Figure 3-4 Long distance transmission of signal (1)



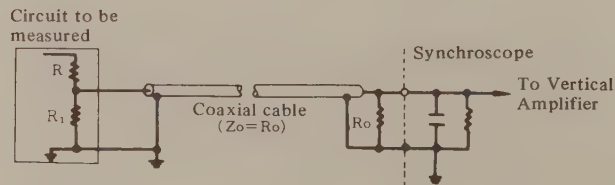
PROPER USE OF PROBE

As mentioned in the foregoing, the use of a probe eliminates externally induced noise and ensures accuracy in measuring high impedance signal sources (the signal to be observed).

Even for complex circuits, the signal to be observed can be easily connected to this instrument by using this probe.

Connect the probe to the INPUT connector for the vertical deflection system of a synchroscope. Secure the ground lead to the probe and the probe clip to the ground terminal of the instrument to be measured.

Figure 3-5 Long distance transmission of signal (2)



PRECAUTIONS ON USE OF PROBE

Maximum allowable input voltage

The maximum allowable input voltage that can be connected to the probe is 500 V (DC + AC peak). Precautions should be taken not to allow the voltage to exceed this rated value. Otherwise, probe insulation may be damaged.

Bayonet adapter

When fast pulses are to be observed, proper grounding of the probe must be observed to avoid distortion of the displayed waveform. For best results, avoid grounding the probe with the ground lead. Instead, use the bayonet adapter, and find a ground point near the point of observation.

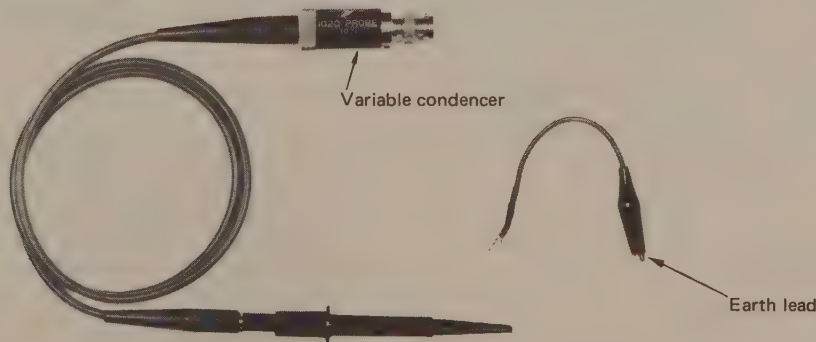
PROBE ACCESSORIES

For effective use of the probe, various accessories are provided as shown in Table 3-2.

PROBE ADJUSTMENT

For accurate measurement using a probe, the probe high frequency response phase and compensating circuit must be

Figure 3-6 Probe (1020)



calibrated in accordance with the input impedance of the instrument.

The phase and compensating circuits for the HF response of the accessory probe are already initially matched to the instrument. Calibration, however, is required for accurate results. (Refer to Chapter 6, "Probe Adjustment.")

Table 3- 2

Accessories	Purpose
Protection Cap 	Protects probe tip from damage when the probe is not being used.
Hook Tip 	Enables the probe to be hooked to the measured.
Bayonet Adaptor 	Used to connect the probe ground close to the point being measured. Prevents waveform distortion when measuring waveforms having fast rise or fall times.
Insulator Tube 	Prevents the probe tip from contacting circuits adjacent to the point being measured.
Probe Hook 	Used to fasten the probe head to the connector of the probe.

VOLTAGE MEASUREMENT

QUANTITATIVE MEASUREMENT

For direct reading of voltage values in quantitative

measurements, the VARIABLE control must be set to the CALIB position. However, quantitative measurement of waveform amplitude is also possible with the VARIABLE control in a position other than CALIB.

- (1) Determine the vertical amplitude of the display on the graticule.
- (2) Connect the calibration voltage (CAL OUT) to the INPUT except for VOLTS/DIV and VARIABLE to obtain a display amplitude comparable to the previously displayed signal amplitude by switching the CAL switch. The vertical deflection sensitivity at these control positions is then calculated from the following equations.

$$\frac{\text{Vertical deflection sensitivity (V/div)}}{\text{Indication of CAL switch (V)}} = \frac{\text{Displayed amplitude of CALIB voltage (div)}}{\text{Displayed amplitude of CALIB voltage (div)}} \dots (3-1)$$

The signal amplitude is calculated from the following equation (3-2).

$$\text{Input signal voltage (V)} = \text{vertical deflection sensitivity (V/div)} \times \text{displayed amplitude (div)} \dots\dots\dots (3-2)$$

DC VOLTAGE MEASUREMENT

This instrument can also be used as a DC voltmeter. First, obtain a trace in the free run mode and select a fast sweep time so that the trace will appear steady.

Turn the AC-GND-DC switch to the GND position, (vertical position of the trace now represents zero volts at the input as shown in Fig. 3-7).

Adjust the vertical position to place the trace on a horizontal graticule line. Change the AC-GND-DC switch to the DC position, and measure the input signal amplitude. Observe the distance between the displayed signal level and

the zero level line. If the signal level is displayed beyond the viewing area, reduce the vertical deflection sensitivity, and repeat the zero level setting and the input signal measurement by changing the VOLTS/DIV switch.

When the signal level is displayed above the zero level, the polarity of the input signal is positive (+), and a negative (−) voltage is displayed below the zero level line. Letting the distance between the two lines represent A (div), the input voltage can be calculated as in equation (3-3) or (3-4).

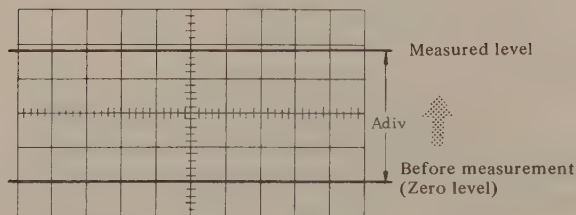
When the 10:1 probe is used for measurement:

$$\text{Voltage (V)} = \text{VOLTS/DIV switch value (V/div)} \times \text{displacement of trace level (div)} \times 10 \quad (3-3)$$

When the voltage to be measured is connected directly to the INPUT,

$$\text{Voltage (V)} = \text{VOLTS/DIV switch value (V/div)} \times \text{displacement of trace level (div)} \quad (3-4)$$

Figure 3-7 DC Voltage Measurement

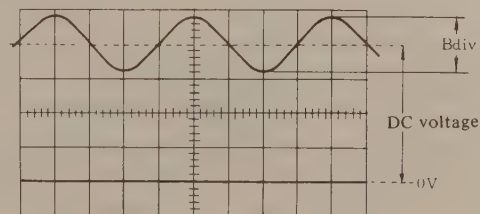


AC VOLTAGE MEASUREMENT

If an AC signal superimposed on a DC voltage with an amplitude larger than that of the AC signal in Fig. 3-8 is measured while the AC-GND-DC switch is in the DC position, the AC component may be displayed out of the viewing area. The AC waveform can be returned to the viewing area of the graticule by adjusting the POSITION control, but this may result in erroneous measurements. The AC position may also be measured by reducing the vertical deflection sensitivity by changing the VOLTS/DIV switch, but this reduces the resolution of the measurement.

The AC position of the AC-GND-DC switch should be used for these purposes. By using the AC position, the DC component of the input signal is blocked by the coupling capacitor, and the AC portion can be displayed at an amplitude which provides sufficient measurement resolution. The absolute value of the AC signal amplitude is

Figure 3-8 AC Signal superimposed on DC Voltage



calculated from equation (3-3) or (3-4).
(It should be noted that the displayed amplitude of an AC signal is attenuated by 3 dB at approx. 3 Hz in the AC mode. When the probe is used, the attenuation is -3 dB at approx. 0.3 Hz.)
The AC signal amplitude calculated from equation (3-3) or (3-4) represents the peak to peak value, and the effective value (V_{rms}) of a sine wave is found as

$$\text{Effective voltage (V rms)} = \frac{\text{Volt (p-p)}}{2 \sqrt{2}} \dots\dots\dots (3-5)$$

CURRENT WAVEFORM MEASUREMENT

Synchrosopes display only the voltage of given signals. Electrical phenomena other than voltage, and mechanical vibrations or other physical phenomena must be converted

into voltage variations before they can be measured.
Current can be measured by reading the voltage drop across a resistor of known value inserted in the circuit being measured. The current is then calculated with Ohm's law, $E = iR$. The value of a resistor inserted in the circuit must be sufficiently small so as not to change the characteristics of the circuit being measured.

When a resistor cannot be inserted in the circuit, the current probe facilitates current measurement without disconnecting the circuit.
When the circuit being measured is isolated from ground, as shown in Fig. 3-9, correct current measurement with a conventional single input instrument is impossible. In other words, a differential amplifier is required.

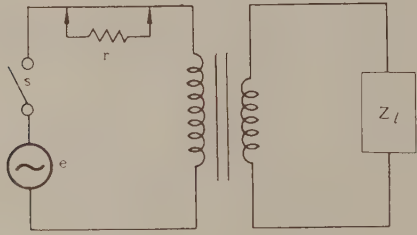
As described in "Dual Trace Measurement and Sum or Difference of Two Frequencies" in Chapter 3, this instrument is provided with a differential measurement function.
For this function, set the MODE and CH2 POLARITY to the ADD and INV positions respectively, and connect the probe tips of the CH1 and CH2 inputs to the ends of resistor "r".

TIME MEASUREMENT

TIME INTERVAL

The time interval between two optional points on a waveform can be read directly by setting the VARIABLE control to the CALIB position and reading the TIME/DIV switch value.
Change the HORIZ DISPLAY switch to the A position, and set the A VARIABLE control to the CALIB position. Trigger the display and set the A TIME/DIV switch to a

Figure 3-9



position which facilitates reading of the distance as shown in Fig. 3-10. The time interval (T) between the two points is calculated as:

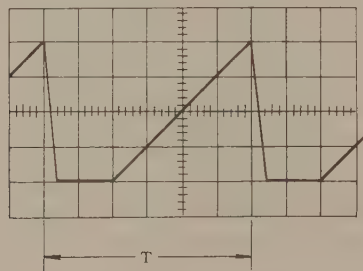
$$T \text{ (sec)} = \text{TIME/DIV switch value (sec/div)} \times \text{distance between the points on the graticule (div)} \times \text{reciprocal of MAG switch value} \quad (3-6)$$

The reciprocal of the MAG switch value is 1 when the display is not magnified and 0.1 when magnified.

TIME DIFFERENCE BETWEEN TWO SIGNALS

The time difference between two signals is easily measured by using the ALT, CHOP, or ADD mode of this instrument. Figs. 3-11 and 3-12 respectively show examples of these measurements.

Figure 3-10 Time interval measurement



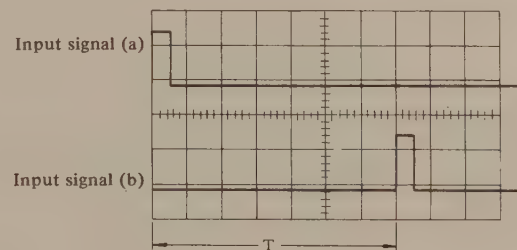
In these modes, the display must be triggered by the leading signal with regard to time, or the SOURCE switch must be set to the channel displaying the leading signal.

Read the distance T from the graticule, and calculate the time from equation (3-6).

LEADING (OR TRAILING) EDGE OF WAVEFORM MEASUREMENT

The signal delay cable provided in the vertical amplifier facilitates internally triggered the rising (or falling) edge of the measurements of leading edge of a waveform (shown in Fig. 3-13) as long as the rise (or fall) time of the waveform is faster than the signal delay time of 80 nsec.

Figure 3-11 Time Difference Measurement in ALT or CHOP Mode

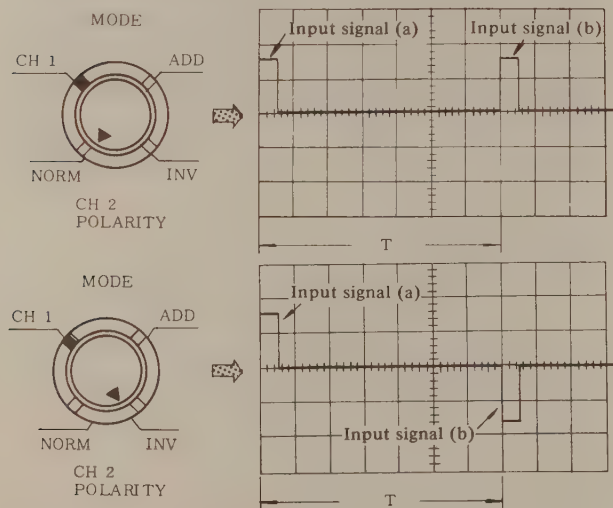


When the rise (or fall) time of a waveform is slower than the signal delay time, the display must be triggered externally.

MEASUREMENT OF PULSE WIDTH

Pulse width is measured as follows.

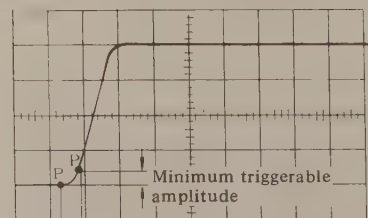
Figure 3-12 Time difference measurement in ADD mode



Adjust the vertical position and amplitude of the display so that the pulse height is equal both above and below the center horizontal line of the graticule (set total height to 2 div or 4 div). Turn the VARIABLE control fully clockwise and set the TIME/DIV switch to a position which allows easiest reading of the display. Read the distance between the centers of the leading and the trailing edges (T), (or crosspoints of these edges and the center horizontal line) from the scale on the horizontal graticule line, as shown in Fig. 3-14. The pulse width is calculated from equation (3-6).

Magnify the horizontal display if the pulse width is very narrow.

Figure 3-13



In the absence of signal delay cable, sweep starts at P.

When a signal delay cable is incorporated, the sweep starts at P'.

RISE (OR FALL) TIME OF PULSE MEASUREMENT

Set the vertical and horizontal position and amplitude controls as in the pulse width measurement. Shift the pulse display horizontally so that the upper 10 % (0.4 div in Fig. 3-15, since the pulse amplitude is 4 div) of the leading edge crosses the vertical center line of the graticule, and read the distance (T_1) between the point where the vertical leading (or trailing) edge of the pulse crosses the horizontal center line, and the vertical center line of the graticule. Adjust the horizontal POSITION control to move the lower 10 % of the leading (trailing) edge so it crosses the vertical center line. Read the distance T_2 . Substitute the value $T_1 + T_2$ in equation (3-6) to obtain the pulse width T (sec).

Direct reading of the pulse width is possible only when the rise (or fall) time of the pulse is sufficiently slower

than the rise time of this instrument, i.e. 1.75 nsec. If a pulse having a very fast rise time is measured, the result obtained from equation (3-6) must be corrected by the following equation (3-7).

$$T_r = \sqrt{T^2 - T_s^2} \quad (3-7)$$

Where, T_r : True value of pulse width
 T : Measured value
 T_s : Rise time of this instrument
 (1.75 nsec)

FREQUENCY MEASUREMENT

Frequency measurements can be largely classified into three types.

Fig. 3-14 Pulse width measurement

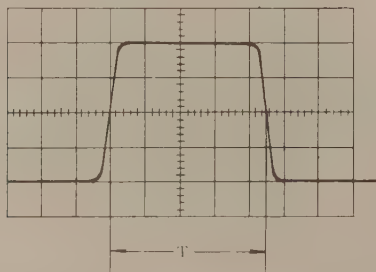
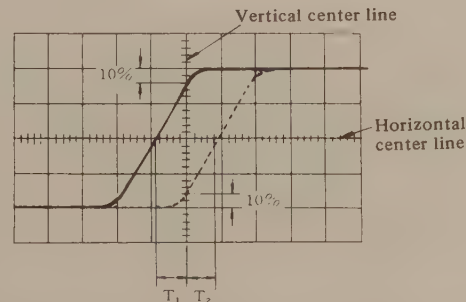


Figure 3-15 Rise (or Fall) Time measurement



First, the frequency can be calculated from the time per cycle (equation 3-6) obtained as shown in Fig. 3-16, and equation (3-8).

$$\text{Frequency } f \text{ (Hz)} = \frac{1 \text{ (cycle)}}{\text{Time } T \text{ (sec)}} \dots\dots\dots (3-8)$$

In Fig. 3-16, the length of one cycle is 8 div and the TIME/DIV switch is in the $1 \mu\text{sec/div}$ position. Thus, the time T is,

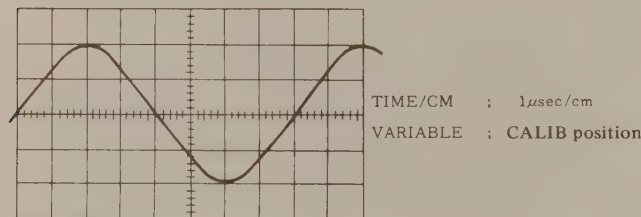
$$T \text{ (sec)} = 8 \text{ div} \times 1 \mu\text{sec/div} = 8 \mu\text{sec}$$

Therefore, the frequency f (Hz) is,

$$f \text{ (Hz)} = 1/8 \times 10^{-6} = 125 \times 10^3 \text{ (Hz)} = 125 \text{ kHz}$$

Second, the frequency can be calculated from equation (3-9) by counting the number of cycles (N) displayed in the horizontal scale (10 div) as shown in Fig. 3-17.

Figure 3-16 Frequency Measurement (1)



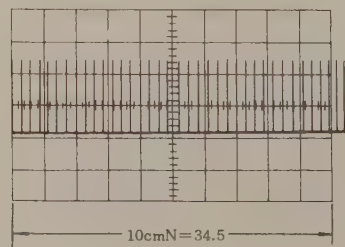
$$\text{Frequency } f \text{ (Hz)} = \frac{N}{\text{TIME/DIV switch value} \times 10} \dots\dots\dots (3-9)$$

This method is more accurate than the former method, and absolute accuracy of measurement approaches that of sweep time, provided that the number of cycles, N , is sufficiently large (30 to 50). When N is comparatively small, reading the value of N below the decimal point becomes uncertain, and accuracy decreases.

PHASE MEASUREMENT BY DUAL TRACE OPERATION (When the two frequencies are equal)

Fig. 3-18 shows an example of a phase difference

Figure 3-17 Frequency Measurement (2)



measurement between two sine waves.

For this method, the TIME/DIV and the VARIABLE control are set so that one cycle of the signal is displayed in exactly 9 div. One vertical division (1 div) represents 40° since one cycle = $2\pi = 360^\circ$ is displayed in 9 divisions, and the phase difference between the signals is calculated by equation (3-10).

Phase difference (degree) = Horizontal distance between the two signals on the graticule (T) $\times 40^\circ$ (3-10)

PHASE MEASUREMENT BY DUAL TRACE OPERATION (When the two frequencies are different)

Fig. 3-19 shows an example of a pulse shaper output and a sawtooth wave triggered by this pulse. To measure

Figure 3-18 Phase Measurement of Two Signals of the Same Frequency

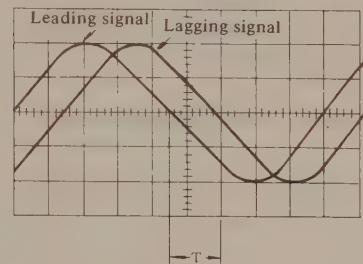
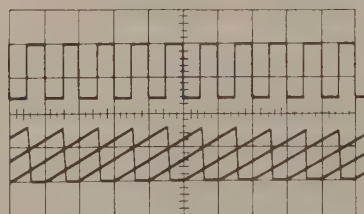
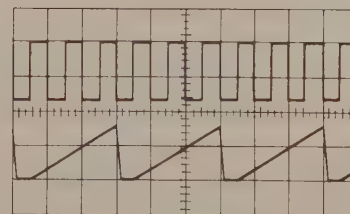


Figure 3-19 Phase Measurement of Two Signals of Different Frequencies



(a) Synchronized by Square wave



(b) Synchronized sawtooth wave

the phase difference of two signals having different frequencies (provided the frequency ratio is an integer), the sweep must be triggered by the lower frequency signal.

If the sweep is triggered by the higher frequency signal (square wave in this example), the sawtooth wave signals will not be triggered properly.

MEASUREMENT OF NON-ELECTRICAL PHENOMENA

Voltage is the only phenomenon which can be measured directly on a synchroscope. Synchrosopes, however, are widely used for measuring phenomena other than voltage as a result of the development of transducers which convert these phenomena into voltage. Transducer type measurements are now practiced in various fields such as kinetics, optics, temperature, and chemistry.

A summary of typical transducers will be described in the following paragraphs.

MEASUREMENT OF KINETIC VARIATION

The following properties of material under external force are employed to convert kinetic variations such as displacement, distortion, pressure, or vibration, into electrical variations.

- (1) Resistance variations of wire resistors and semi-conductors due to externally applied force. These devices are known as strain gages.
- (2) Piezoelectric elements such as quartz crystals or barium titanate which produce an electrical output

proportional to an externally applied force.

- (3) Capacitance pick up which varies its internal capacitance in accordance with an externally applied force.
- (4) Ferromagnetic pick up which varies its magnetic properties with external force.
- (5) Electromagnetic pick up. Converts displacement into electromagnetic force.

Various other types of transducers are also produced. All these transducers are attached either directly or through an adequate material to the object being measured.

These transducers may be classified according to their purpose, such as distortion measurement, pressure, or vibration, etc. These devices can be further classified into types which operate at high temperature or humidity, high frequency, large amplitude vibration, and those which are extremely sensitive for minute vibrations, etc.

Various new transducers are being developed, and additional applications using synchrosopes for measuring physical properties are expected.

OPTICAL AND TEMPERATURE MEASUREMENT

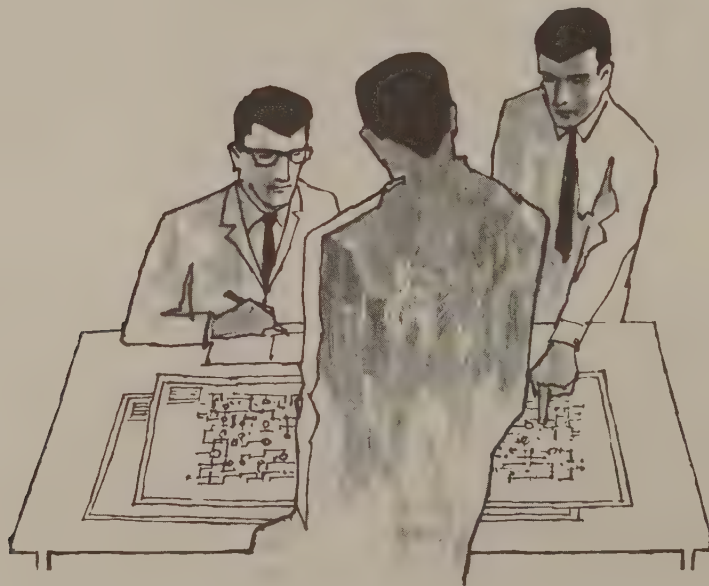
Transducers which convert light variations into electrical variations are commonly known as photoelectric cells and phototransistors. Photomultiplier tubes are used for detecting very dim or minute changes of light.

Thermistors, of which electrical resistance varies with temperature, and thermocouples composed of two dissimilar metals (copper and constantan wires) which generate an electromotive force when their junction point is heated, are the most commonly used thermal transducers.

MEMO

CHAPTER 4 PRINCIPLES OF OPERATION

The operation of the instrument will be described in this chapter, based on the block diagram in Figure 4—1.



GENERAL

The circuit configuration of this instrument is shown in Fig. 4-1. Each block operates, as the final purpose, to deflect the deflection beam of the CRT.

Two independent preamplifiers are provided for the vertical deflection system. The input signal is connected to the INPUT connector, then amplified and converted into a balanced signal and fed to the switching circuit.

A diode gate in the switching circuit determines the connection of the input(s) (CH1, CH2, or both) to the main amplifier. The MODE switch selects either CH1, CH2, the two signals switched electronically (ALT or CHOP), or the algebraic sum or difference of the two signals (ADD). In the ALT position of the MODE switch, the diode gate is switched by a trigger signal from the A sweep generator, and the CH1 and CH2 signals are alternately displayed. In the CHOP mode the two signals are chopped, regardless of the sweep rate, at a repetition rate of approximately 1 MHz. In this mode, the switching waveform (chop blanking pulse) is supplied to the Z axis amplifier to blank transients of the switching.

The main amplifier functions to amplify the balanced signal up to a sufficient level to deflect the electron beam of the CRT vertically.

A part of the signal fed to the INPUT connector is also fed internally to the trigger amplifier from the preamplifier (the signal fed to the trigger amplifier is called trigger signal) where it is amplified and fed to the A and B trigger generators (the polarity of the B trigger signal is reversed with respect to that of the A trigger signal). The signal fed to the CH2 INPUT is amplified by 5 times and supplied to the CH2 OUT connector.

The A and B trigger generators convert the trigger signal

into a trigger pulse having a constant amplitude and pulse-width. The trigger pulse may also be generated by an external trigger signal supplied to the TRIG INPUT connector. The A sweep generator is triggered by the A trigger generator, and the B sweep generator by the B trigger generator. The A and B sweep generators are interconnected for delayed sweep operation. Three types of interconnection are provided; the $\langle A \leftrightarrow B \rangle$ connection for the delay sweep, the $\langle A \rightarrow \text{control circuit} \rightarrow B \rangle$ connection to control the width of the intensified part of the display in the A INT BY B mode, and the $\langle B \rightarrow \text{control circuit} \rightarrow A \rangle$ connection to intensify the display in the DLY'D mode. The control circuit is used manually to control the width of the intensified part of the display in both the aforementioned A INT BY B and DLY'D modes.

The horizontal amplifier functions to amplify the sawtooth wave generated by the A,B sweep generator up to a sufficient level to deflect the electron beam of the CRT horizontally.

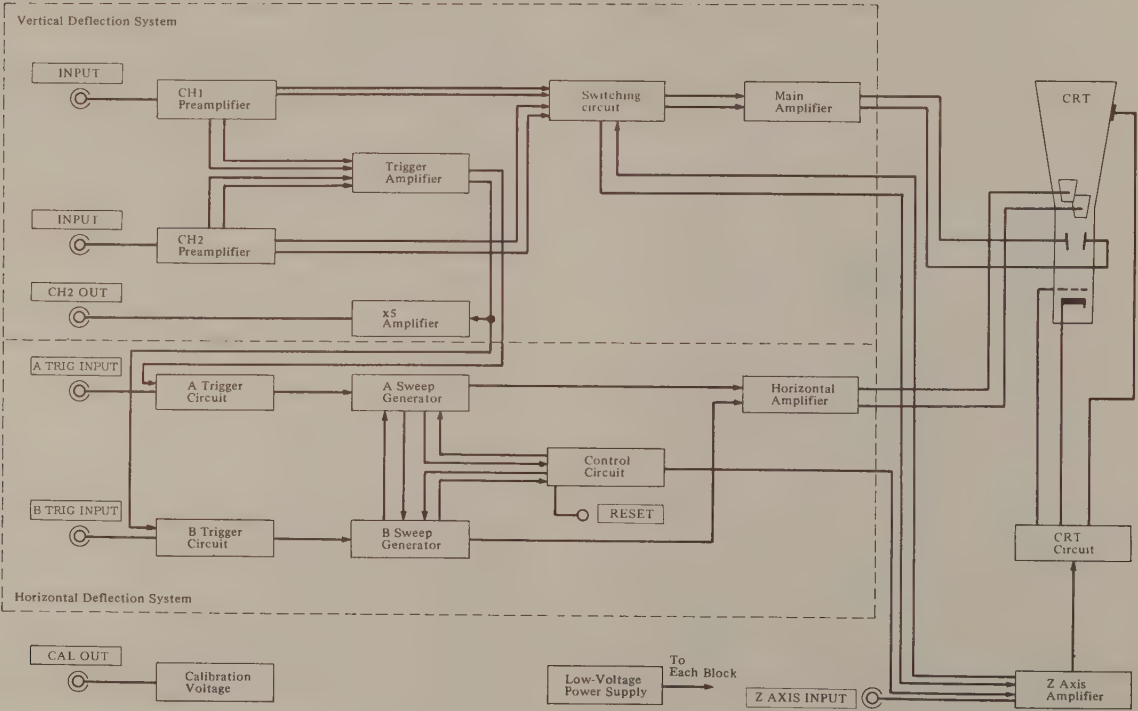
Z axis amplifier amplifies unblanking signals from the control circuit, chop blanking pulses from the switching circuit and the external intensity modulation signals fed from the Z AXIS INPUT connector, and depending on the setting of the INTENSITY control, the Z axis amplifier determines the bias voltage of the CRT. These signals and voltages are fed through the CRT circuit to the control grid of the CRT to control the trace intensity.

The CRT circuit produces the high voltage required to emit and accelerate the electron beam.

The 6.3 V AC used for the CRT filaments and graticule illumination lamps, and the low DC voltages required for the operation of circuits are obtained from the low voltage power supply.

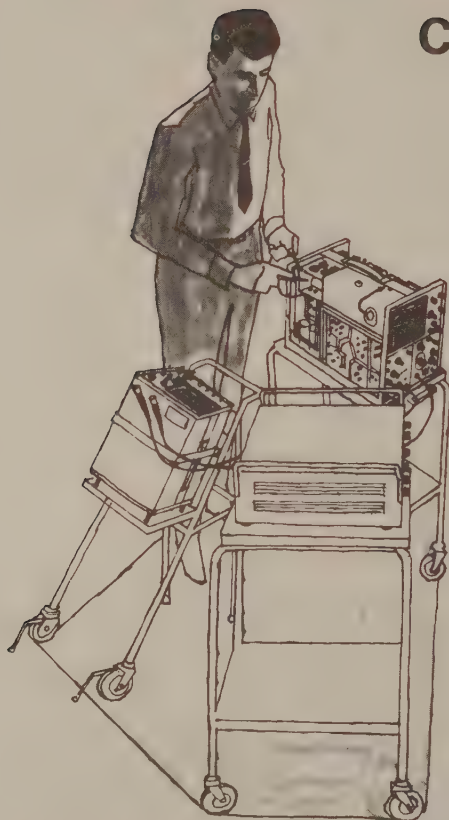
The calibration voltage generates the square wave voltage to calibrate the instrument.

Figure 4-1 Basic block diagram



MEMO

CHAPTER 5 MAINTENANCE



This chapter of the manual gives maintenance notes for the MODEL SS-200. This instrument requires a normal amount of maintenance; however normal aging of electronic components may cause abnormal operation eventually.

Use of the following procedures should prevent many minor malfunction or permit their detection before a major repair is required.

PREVENTIVE MAINTENANCE	5-1
TROUBLESHOOTING	5-2
PARTS REPLACEMENT	5-7

PREVENTIVE MAINTENANCE

Maintenance procedures listed herein outline periodic tests which insure optimum operating efficiency and indicate preventive maintenance measures when required.

CLEANING

The instrument should be kept clean at all time. Accumulation of dust in the instrument affects the radiation of heat and may cause overheating and the subsequent failure of parts. Dust on switch contacts, connector or printed circuit boards result in poor contact and it may come arcing in humid atmosphere. Suitable cleaning agents are listed in Table 5-1. Those agents indicated as unsuitable must not be used.

Table 5-1

Suitable Cleaning Agents	Alcohol, and xylene
Unsuitable	Acetone, methyl-ethyl-ketone, ether, lacquer thinner, and chemicals containing ketone series solvents

Front panel cover

Ordinary dirt on the front panel cover can be removed by washing the cover with a mild detergent solution. When grease or oil is present, use a soft cloth and one of the preferred cleaning agents listed in Table 5-1.

Front panel and controls

Clean the front panel and controls with a damp cloth

and a detergent or a suitable solvent. Use of alcohol may result in slight discoloring of the panel. If a powdered cleanser is used, wipe off the cleanser which remains after drying.

Dirt in instrument

Remove the two side panels and inspect the interior of the instrument. If an excessive amount of dust is present inside the instrument, use a soft paint-brush and low-pressure air stream or vacuum cleaner.

Dirt on CRT surface

If the CRT polarized filter is left off for a long time, the CRT faceplate may become dirty. Dust or fingerprints can be removed by wiping the surface with a soft cloth dampened with alcohol.

Polarized filter

The mesh CRT filter can be cleaned by using a soft artist's brush to remove dust, and mild detergent and water to remove stains. After washing, rinse with clear water and allow the filter to air dry.

Do not use a hard or sharp-pointed tool on the filter; the mesh may be damaged.

WHEN THE INSTRUMENT IS NOT TO BE USED

When the instrument is not going to be used for a certain period, disconnect the probe and adapter from the panel and cover the instrument with the protective dust cover. Store the accessories in the accessory bag and place the instrument in a dry place.

VISUAL INSPECTION

A simple visual check of the inside of the instrument will sometimes find various defects, such as charred resistors, defective contacts, or broken circuit boards. Immediate repair of these minor defects will prevent the instrument from more serious troubles.

TROUBLESHOOTING

A thorough understanding of the overall system and circuit operation of this instrument will prove to be a valuable aid in troubleshooting.

TROUBLESHOOTING REFERENCES

Circuit diagrams

The circuit diagrams are classified in accordance with the blocks shown in Fig. 4-1 "Basic Block Diagram." Circuits enclosed by dotted lines in the block diagram are on printed circuit boards.

The location of contacts and wafers of each rotary switch are also indicated. Contact positions on the side of a wafer closest to the front panel are denoted as A-F, and those on the rear side of the front wafer are A-R. Subsequent wafers are indicated as B-F and B-R. Concentric shaft switches are described as aA-F, aA-R,..... (switch closest to front panel and driven by the outer shaft) and bA-F, bA-R,..... (rear switch, driven by the inner shaft).

Location of circuit boards

The schematic diagrams in the last section of this manual show the Circuit Boards, and will help in checking these circuits.

Parts arrangement diagrams

The parts diagrams of each circuit boards in the last section will aid in checking or replacement of parts.

Wiring color code

Wires are color coded according to their function. Two-colored wires are for the power supply circuits, and solid color wires are used for the general circuit wiring. The color code of wires is shown in Tables 5-2 and 5-3. Table 5-3 shows a typical use of wires, although some wires in this instrument may be out of the code. Shielded wires are not included in these codes.

Table 5-2 Power Supply Wiring Color Code (Two-Colored)

Power Supply	Base Color	Stripe Color
- 12 V	White	Black
+12 V	White	Orange
+70 V	White	Red
+110 V	White	Yellow
+130 V	White	Blue

Table 5—3 General Wiring Color Code (Solid Color)

Circuit	Color
Collector or drain wires	Red
Base or gate wires	Yellow
Emitter or source wires	Blue
Positive voltage wires	Brown
Negative voltage wires	Purple or gray
Others (signal line, etc.)	White
Ground wires	Black

Resistor and capacitor color code

The resistors and capacitors used in the circuit are color coded as shown in Fig. 5—1.

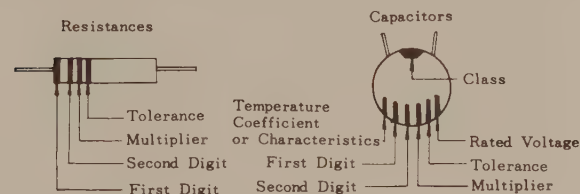
Identification of diode and transistor elements

Element identifying marks for the various diodes and transistors are shown in Table 5—4 and 5—5.

PRIOR TO TROUBLESHOOTING

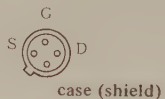
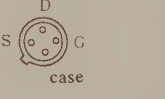
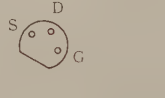
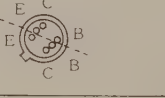
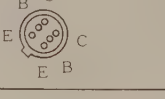
First, it should be determined whether the instrument is actually defective, or whether external conditions are

Figure 5—1 Resistor and Capacitor Color Code



Color	Resistance or capacitance value		Tolerance for resistance (%)	Tolerance for capacity (%)		Rated voltage (Capacitor)
	1st and 2nd significant digits	Multiplier		10 pF or more	10 pF or less	
Black	0	1	—	±20.0	± 2.0	—
Brown	1	10	± 1	± 1.0	—	—
Red	2	10 ²	± 2	± 2.0	—	250 V
Orange	3	10 ³	—	± 2.5	—	300 V
Yellow	4	10 ⁴	—	—	—	—
Green	5	10 ⁵	—	± 5.0	± 0.5	500 V
Blue	6	10 ⁶	—	+ 100 (- 0)	—	—
Purple	7	10 ⁷	—	—	—	—
Gray	8	10 ⁸	—	±10.0	±0.25	—
White	9	10 ⁹	—	—	± 1.0	1000 V
Gold	—	10 ⁻¹	± 5	—	—	—
Silver	—	10 ⁻²	±10	—	—	—
Not colored	—	—	±20	—	—	—

Table 5-4 Type and Lead Identification of Transistors

Type	Element Identification
2SJ12 2SK12	
T1S27	
2N4416	
2N4360	
N501BFY	
μ PA15	

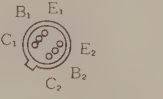
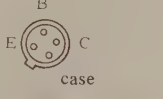
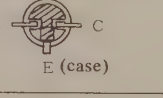
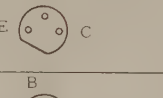
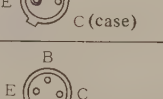
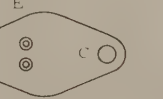
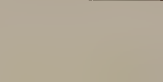
MD3250	
2N4957 2N4260 2N3571 (SELECT)	
2SC989	
2N4275 2N4258	
2SD221 2SC510 2N3634	
2SC321 2N5109 BFW30 2N5179 2N3119 2N3500	
2SC857 2SC650 2SC857(K) 2N4121 2N4122	
2SD93 2N3055 2SD166 2SD198	

Table 5-5 Type and Lead Identification of Diodes

Type	Shape and Polarity	
	Shape	Polarity
LA60 5EH12		
HF SD-1		
1N754A 1S993 1S953 (Element symbol is orange) 1S955 (Element symbol is green)		
HW6.8A HW33A HW18B HW56A HW24B HW91A HW30B (A: $\pm 10\%$, B: $\pm 5\%$)		
V03C V06E	 Element symbol belt	
1S1458	 yellow	
1S467	 green	
1S1992	 white red	
1S1760 1S1763		
1S1762		
1S552		

responsible for the trouble. For example, when the power source voltage exceeds the allowable operating range, or external noise is induced in the test set-up, the display will become irregular.

When the display at a certain sweep rate is somewhat irregular and it is difficult to determine whether the instrument is defective, it is advisable to observe another signal and see if the same irregularity occurs.

RECOMMENDED TEST EQUIPMENT FOR TROUBLESHOOTING

The following is a list of the test equipment recommended for locating troubles in the MODEL SS-200.

- (1) High impedance Volt-Ohmmeter
 - Input Impedance: Not less than $10\text{ M}\Omega$
 - Voltage Range: Normal range $0 - 300\text{ V}$, should be capable of measuring 2 kV with high-voltage probe.
 - Ohmmeter Range: $0 - 20\text{ M}\Omega$
- (2) Transistor Curve Tracer
IWATSU Transistor Curve Tracer TT-502 or TT-505
- (3) Test Synchroscope
Frequency Bandwidth: $\text{DC} - 100\text{ MHz}$
Sensitivity: 5 mV/cm

TROUBLESHOOTING PROCEDURE AND SEQUENCE

The following procedures and sequence of troubleshooting will help to save time.

- (1) Before removing the side or rear panel from the instrument, verify all control functions described in Chapter 2, "Operating Procedures." This should aid in isolating the defective portion to a particular circuit such as the low voltage power supply, CH1 preamplifier, CH2 preamplifier, trigger generator and so on. (Refer to the following section "Isolation of Defective Circuits According to Trouble Symptoms.")
- (2) Next, remove the cover on the side of the instrument which contains the suspicious circuit, and check visually components, wires, and the circuit pattern for irregularities such as charred wires or resistors, defective contacts or broken wires. Various causes of trouble may be detected by a thorough visual inspection.
- (3) Check the low and high voltage supplies. Trouble in the low voltage power supply has considerable influence on other circuits. Abnormal voltage from power supplies must be corrected.
- (4) Next, use a Volt-Ohmmeter or test synchroscope to check the operation of individual circuits, referring to the circuit diagrams in the last section, and localize the defective circuit.
- (5) Check the characteristics of suspicious active elements (transistors or diodes) and passive parts (resistors or capacitors, etc.). Replace any defective part(s). Two or more parts may be defective. The plug-in unit can be connected for circuit testing by using the extension connector. See Fig. 5-2.

TROUBLESHOOTING WITH PARTICULAR SYMPTOMS

Since it is impossible to forecast all possible troubles in this synchroscope, only typical troubles and troubleshooting hints will be described. Follow the procedures described in items 3) to 5) above to isolate defective parts.

No spot

The CRT circuit, Z axis amplifier, vertical deflection system circuit or horizontal amplifier is responsible for this trouble. Although it is a rare case, two of these circuits may cause trouble at the same time.

Figure 5-2 Connection of extension cords and connectors



Change the MODE switch from CH1 to CH2, or vice versa, to confirm that the spot is present on both channels. If the spot is not present on one channel, the preamplifier in that channel is probably defective.

If it is not present in either channel, check that the DC voltage on each deflection plate, or the output voltages of the vertical and horizontal amplifiers, are balanced at a certain position of the POSITION control for the deflection system. When the deflection plate voltages for one axis are balanced but the spot is still not present, the CRT circuit or Z axis amplifier is probably defective. Normal operation of the Z axis amplifier can be easily checked by checking the Z axis output waveform, or the unblanking voltage.

Spot is present but sweep does not operate

Turn the POSITION control (horizontal). When the spot moves horizontally the display with the rotation of this control, the horizontal amplifier is normal, and the sweep generator circuit is responsible for the defect.

Sweep present but not triggered

When the display cannot be triggered by either the internal or external trigger, the trigger generator is defective. If the display is triggered only by an external trigger signal (of rated amplitude), the trigger amplifier is defective.

Dual trace inoperative

When only the ALT mode is inoperative, the circuits between the alternate pulse output of Z Axis amplifier and

switching circuit may be the cause of the trouble. In very rare cases, the switching circuit may be defective. When both the ALT and CHOP modes are inoperative, the switching circuit is probably defective.

Horizontal sweep is not linear

If the sweep time in the right and left sides of the display area is not equal, and the display linearity varies with rotation of the POSITION (horizontal) knob, the horizontal amplifier is probably defective, and if the linearity does not vary with the POSITION control, the sweep generator is the most likely cause.

PARTS REPLACEMENT

The procedure for removing panel covers and replacement of defective components will be described.

REMOVAL OF PANEL COVERS

The top and bottom panels can be removed in the following sequence. Remove the four screws on the top panel and the two screws on the right panel to remove the top panel. Remove the six screws located at the bottom cover and the two screws at the right panel to remove the bottom cover. The rear panel can be removed by removing the four screws.

REPLACEMENT OF SEMICONDUCTORS

Suitable transistors or diodes must be used for replacement. Specially selected transistors are employed in major circuits of this instrument in order to ensure the characteristics described in Chapter 1.

The semiconductors are sensitive to heat. When the transistor leads are soldered, use heat sinks to prevent the conduction of heat to the actual internal elements. Replace parts as quickly as possible as heat may cause the printed circuits to separate from the laminate.

REPLACEMENT OF RESISTORS AND CAPACITORS

Specially selected passive elements, (resistors and capacitors), are used for the instrument, therefore defective parts should be replaced with suitable replacement.

Heat damaged resistors or conducting capacitors may result from shortcircuiting or serious deterioration of transistors or diodes. Check the cause of the trouble, and replace any defective active elements as well as passive elements.

REMOVAL OF PRINTED CIRCUIT BOARDS

The printed circuit boards can be removed by disconnecting the wires to the board and removing the mounting screws.

The external connections to the board must be soldered properly after replacement in order to avoid damage to transistors and/or resistors.

CRT REPLACEMENT

Handle the CRT with extreme care as excessive force or shock may cause it to break or crack. If the deflection plate pins or electrode pins are bent, it may cause the glass sealant around the pins to crack.

Remove the CRT in the following sequence.

- (1) Remove both side panels and the rear panel.
- (2) Unsolder the wire leads from the rotation and other coils of the CRT.
- (3) Remove the connectors from the deflection plate pins on the neck of CRT and the anode cap on the left front side of the CRT.
- (4) Remove the CRT socket.
- (5) Remove the two horizontal mounting screws on the neck of the CRT.
- (6) Remove the four screws which secure the bezel to the front panel, and remove the bezel and filter.

Then, pull the CRT out the front side of the instrument.

Reinstall the CRT in the reverse sequence. Be sure the deflection plate connectors are correct. Pattern distortion correction and XY axes alignment differ with individual CRT's. These items must be calibrated after replacement of the CRT.

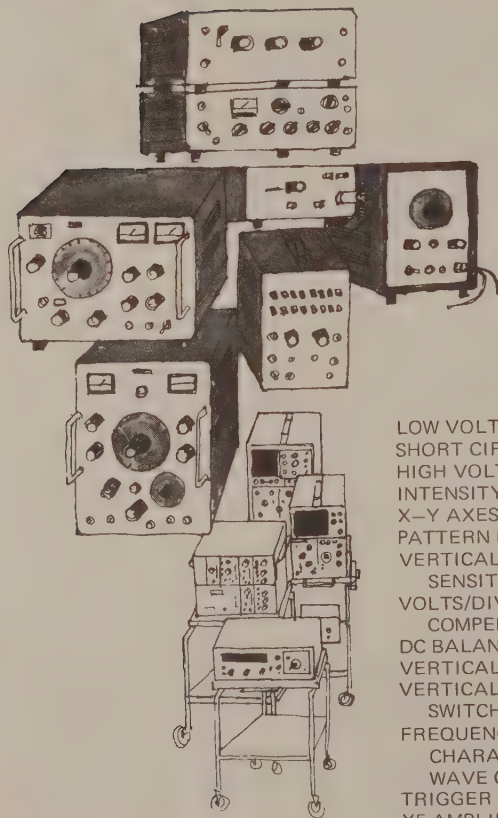
FUSE REPLACEMENT

The power line fuse is located on the rear panel, and low voltage power supply fuses are collectively arranged on a fuse board on the top section inside the instrument.

Details of fuses are shown in Table 5-6.

Table 5—6 Fuses

Circuit Symbol	Fuse Type	Function	Location of Fuse Holder
F1301	0.5 A Slow-blow	High Voltage	Top panel of instrument (arranged on a fuse board)
F1401	2 A Slow-blow	For AC 100 V operation	Rear panel (fuse holder)
	1 A Slow-blow	For AC 200 V operation	
F1402	0.25 A	+130 V	Top panel of instrument (arranged on a fuse board)
F1403	0.25 A	+110 V	"
F1404	0.5 A	+70 V	"



CHAPTER 6 CALIBRATION

Like all measuring instruments, this synchroscope must be calibrated after a certain amount of use. The extent of calibration is determined by the operating condition of the instrument and the functions which require calibration can be determined by checking the accuracy of the vertical deflection sensitivity, attenuator (VOLTS/DIV) response, sweep time, and other functions by using the internal CALIBRATOR or accurate external instruments.

Partial calibration may influence other circuits, i.e. the low voltage power supply influences operation of almost all circuits, and the high voltage power supply varies the vertical and horizontal deflection sensitivity. Upon instrument repair, an overall calibration may be required.

LOW VOLTAGE POWER SUPPLY	6- 1
SHORT CIRCUIT TEST	6- 1
HIGH VOLTAGE POWER SUPPLY	6- 1
INTENSITY	6- 5
X-Y AXES ALIGNMENT	6- 5
PATTERN DISTORTION	6- 6
VERTICAL DEFLECTION SENSITIVITY	6- 6
VOLTS/DIV (ATTENUATOR) COMPENSATION	6- 7
DC BALANCE	6- 8
VERTICAL POSITIONING	6- 8
VERTICAL POSITION SHIFT DUE TO SWITCHING OF CH2 POLARITY	6- 8
FREQUENCY RESPONSE CHARACTERISTICS AND SQUARE-WAVE CHARACTERISTICS	6- 9
TRIGGER AMPLIFIER	6- 9
X5 AMPLIFIER	6- 9

A AND B TRIGGER GENERATOR LEVEL CENTER	6- 9
TRIG STABILITY	6-10
A AND B SWEEP GENERATOR T.D. BIAS	6-10
STABILITY	6-10
A SWEEP TIME	6-10
X10 MAG	6-11
MAG CENTER	6-11
B SWEEP TIME	6-11
DELAY TIME MULTI	6-14
CALIBRATOR CAL OUTPUT VOLTAGE	6-15
CAL FREQUENCY	6-16
PROBE CALIBRATION	6-16
PROBE COMPENSATION	6-16
HIGH FREQUENCY COMPENSATION	6-16

LOW VOLTAGE POWER SUPPLY

The low voltage power supplies must be checked prior to calibration of other circuits. The low voltage power is supplied to all circuits, therefore, the output voltages of power supplies must be adjusted by using an accurate DC voltmeter (0.5 % accuracy or higher).

Both regulated and unregulated (UNREG) power supplies are provided as shown in Table 6-1. The location of test points on the power supplies is shown in Fig. 6-1. Measure the voltage between the test point and ground, and if any error is found, adjust the output voltage in the sequence shown in Table 6-1. Variable resistors for each adjustment are also indicated in Table 6-1.

Table 6-1

Power supply	Type	Color code of wiring	Tolerance	Ripple voltage	Measuring condition	Adjustment	Variable resistor for calibration
-12 V	Regulated	White/black	0 %	Approx. 100 μ V	Calibrate at power line voltage of 100 V	1	R1407 -12 V ADJ
+12 V	"	White/orange	0 %	"	"	2	R1414 +12 V ADJ
+70 V	"	White/red	± 1 %	Approx. 3 mV	"	—	—
+110 V	"	White/yellow	± 1 %	"	"	—	—
+130 V	"	White/blue	± 1 %	"	"	—	—
-20 V	Un-regulated	White/gray	Approx. -20 V	—	"	—	—
+35 V	"	Orange	Approx. +35 V	Approx. 3 mV	"	—	—

SHORT CIRCUIT TEST

Ground the -12 V and +12 V power for 2 - 3 seconds, and check for normal operation of the instrument.

HIGH VOLTAGE POWER SUPPLY

Variation of the high voltage will cause variation in the deflection sensitivity of both the vertical and horizontal axes of the CRT. An excessive voltage variation will vary the focus of the CRT. The two voltages in Table 6-2 should be adjusted or confirmed.

Figure 6-1 Rear view

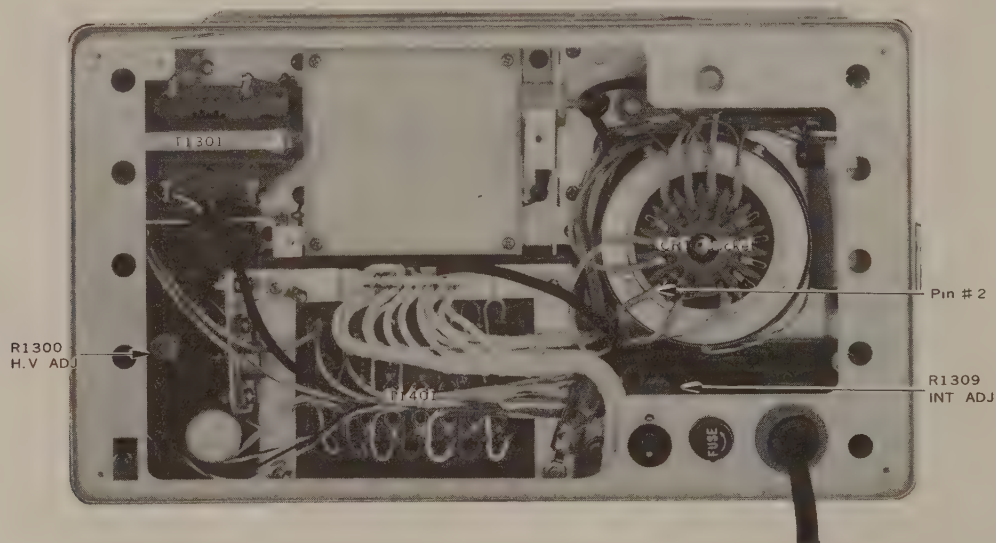


Figure 6-2 Top view

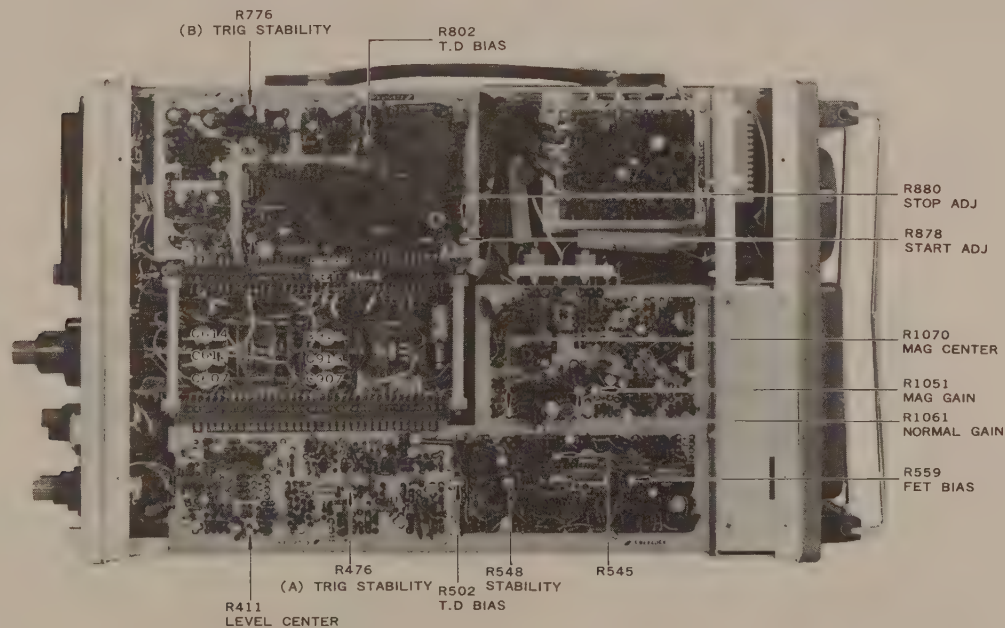


Figure 6-3 Bottom view

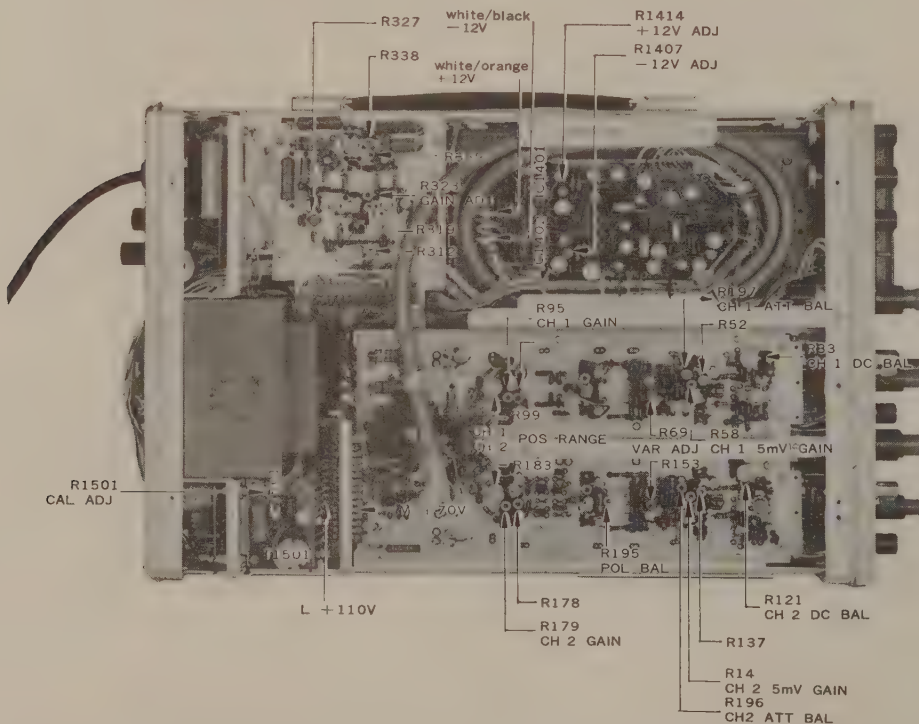


Table 6-2

High voltage power supply	Wire color	Normal value	Variable resistance for calibration
CRT cathode — earth	White/brown	-1.45 kV ±30 V	R1300
CRT anode — earth	Red	+13.5 kV ±0.5 kV	—

First, measure the cathode voltage. If the voltage across the cathode (pin # 2 of the CRT) and ground is not in the specified range, adjust it to -1.45 kV, with R1300 H.V ADJ (Fig. 6-1).

Next, check anode voltage. To prevent measurement error caused by parallel connection of voltmeter to the CRT, turn the power switch OFF and remove the anode cap from the anode of the CRT. Be sure that the anode cap does not contact any other part or chassis. Connect the voltmeter to the anode cap and chassis, and turn the power switch ON. The anode voltage must be +13.5 kV to chassis.

Caution

Particular care must be taken to prevent hazard from the high voltage, +13.5 kV, during the removal of anode cap and voltage measurement.

INTENSITY

Poor intensity will hamper observation of the display, and excessive intensity will burn the phosphor coating of the CRT.

The optimum intensity is obtained at the following position of the INT ADJ R1309 (Refer to Fig. 6-1). Adjust the control so that the spot appears when the INTENSITY control is turned fully clockwise with no sweep, and the trace just disappears when a sweep is present and the INTENSITY control is turned fully counterclockwise.

Caution

Use insulated screwdriver to adjust the INT ADJ control, R1309, because the control is connected to the high voltage source.

X-Y AXES ALIGNMENT

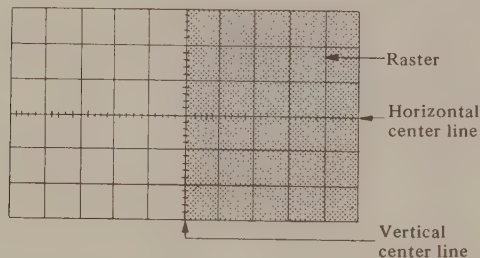
Variation in earth magnetism may cause variation in the alignment of the X or Y axis of the display and the graticule scale. The X and Y axes can be aligned with the graticule scale in the following procedure.

- (1) First, adjust the TRACE ROTATION control R1322 (a screwdriver adjustment potentiometer, refer to Fig. 2-5) so the horizontal trace coincides with the horizontal centering of the graticule scale.
- (2) Short the vertical deflection pins of the CRT with lead and alligator clip, and adjust R1324 · ORTHO(1) and R1326 · ORTHO(2) (refer to Fig. 6-9) so the horizontal trace coincides with the center horizontal line of the graticule scale. Set the variable resistors as close to mid-position as possible.
- (3) Disconnect the short with lead and alligator clip from the vertical deflection pins. Feed a signal to the INPUT, place the sweep mode in the AUTO position

(free running) to display a raster (Fig. 6-4), and overdrive the vertical amplifier. Confirm that the amplitude of the raster exceeds the viewing area.

- (4) Reduce the vertical amplitude of the raster to 6 div, and adjust the top and bottom edges of the raster to coincide with the graticule scale. Adjust the horizontal position of the display so that the raster starts from the center of the graticule (cross point of the two center lines). Adjust R1324 and R1326 so the starting line of the trace coincides with the center horizontal line of the graticule. These adjustments interact, therefore should be repeated until both are correct. If the alignment of the horizontal trace in item (1) deviates from the horizontal center line of the scale after the vertical alignment, adjust the TRACE control so the horizontal trace coincides with the scale, and repeat items (1) to (4).

Figure 6-4 Raster



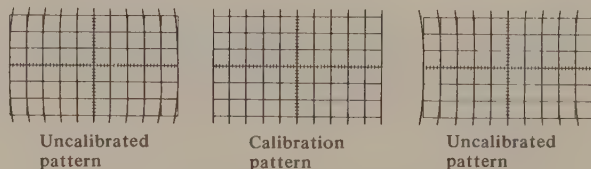
PATTERN DISTORTION

Feed the CAL output to the input connector, and overdrive the vertical amplifier. Adjust the TIME/DIV and A VARIABLE switches so that the vertical trace is displayed at 1 div intervals (see Fig. 6-5). Adjust the GEOM R1321 (refer to Fig. 6-9) and the INTER PLATE SHIELD R1327 (Fig. 6-9). Simultaneously halation is eliminated from the display. Note that adjustment of R1321 and R1327 will vary the focus. The focusing is controlled with the FOCUS control and ASTIG (a screwdriver resistor - refer. to Fig. 2-5). Adjust R1321 so it will simultaneously satisfy the pattern distortion and focusing.

VERTICAL DEFLECTION SENSITIVITY

Connect a calibrated signal generator (CR oscillator) and

Figure 6-5 Calibration of pattern distortion



feed a 1 kHz signal exactly 20 mVp-p in amplitude to the CH1 and CH2 INPUT connector. Adjust R95 CH1 GAIN and R179 CH2 GAIN (refer to Fig. 6-3) for proper display. (The free-running will ease the adjustment).

Change the VOLTS/DIV switches of CH1 and CH2 to 5 mV/div position. Reduce the input voltage to 10 mVp-p. Amplitude of display should remain in 2 div. on the graticule, otherwise, adjust R58 CH1 5 mV GAIN and/or R142 CH2 5 mV GAIN. (Refer to Fig. 6-3).

VOLTS/DIV (ATTENUATOR) COMPENSATION

If the characteristics of the attenuator are not equal for each range, frequency response will deteriorate and distortion will occur in the displayed waveform.

Connect the probe of INPUT of the synchroscope and to a square wave oscillator (1 kHz and low output impedance) having a fast rise time (0.1 μ sec or better). Set the VARIABLE control to the CALIB position and the VOLTS/DIV switch to the 5 mV position.

Adjust the square wave oscillator output so amplitude of the displayed waveform will be 3 to 4 divisions, and position the waveform symmetrical to the horizontal center line. Calibrate trimmers in the attenuator, after properly triggering the display.

Refer to paragraph "Probe phase calibration" for function of the trimmer capacitors to obtain the correct waveform shown in Fig. 6-7.

The part A is calibrated with C30A (for CH1) and C30B (for CH2). For calibration of part B, C76 (for CH1) and C55 (for CH2) are used.

Change the CH1 and CH2 VOLTS/DIV switches sequentially, and calibrate the attenuator as described in Table 6-3. Note that the calibration is not required for the 10 mV position.

In the columns in Table 6-3 below 20 mV ($\times 2$), channel numbers are omitted. Capacitors listed in column A are for CH1 and those in column B are for CH2.

Table 6-3

VOLTS/DIV Range	Attenuation Ratio	Calibration trimmer	
		Part A	Part B
5 mV	X 1	CH1 C30 A	CH1 C76
10		CH2 C30 B	CH2 C55
20	X 2	C 6 AB	C 4 AB
50	X 5	C 8 AB	C 7 AB
.1 V	X 10	C10 AB	C 9 AB
.2	X 20	C12 AB	C11 AB
.5	X 50	C14 AB	C13 AB
1	X100	C16 AB	C15 AB
2	X200	C18 AB	C17 AB
5	X500	C20 AB	C19 AB

DC BALANCE

- (1) Adjust R69 BAL ADJ (for CH1) and R153 BAL ADJ (for CH2), refer to Fig. 6-3, to set emitter voltages of TR36, TR37 (CH1), TR48 and TR49 (in CH2) to +2.7 volts. During the adjustment, the VARIABLE controls must be set to the CALIB position.
- (2) Adjust R33 DC BAL (for CH1) and R121 (for CH2), refer to Fig. 6-3, until DC level of vertical amplifiers is held stable against rotation of the CH1 and CH2 VARIABLE controls. In short, adjust these variable controls so that the traces will be held in a fixed position against change in setting of VARIABLE controls in the free-running mode.
- (3) Adjust the ATT BAL controls, R197 for CH1 and R196 for CH2, refer to Fig. 6-3, so that the traces

will not shift when the VOLTS/DIV switches are switched from the 5 mV and 10 mV positions.

VERTICAL POSITIONING

Turn the POSITION controls to mid-position and adjust R99 POS RANGE (R183 for CH2) to set the trace to center of graticule. (Fig. 6-3).

VERTICAL POSITION SHIFT DUE TO SWITCHING OF CH2 POLARITY

If the vertical position of the display shifts when the CH2 polarity switch is changed, adjust R195 POL BAL

Figure 6-6 Attenuator

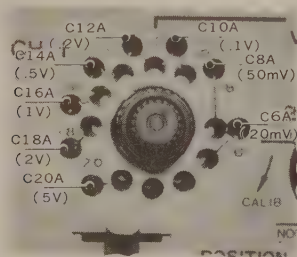
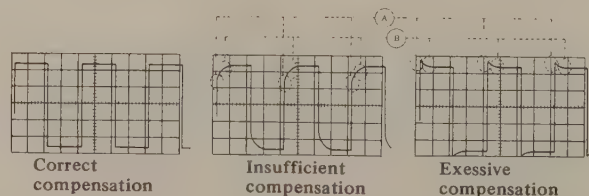


Figure 6-7 Compensation of VOLTS/DIV



(Refer to Fig. 6—3) to eliminate the vertical shift of the display between the different switch positions.

FREQUENCY RESPONSE CHARACTERISTICS AND SQUAREWAVE CHARACTERISTICS

Rated frequency characteristics for vertical amplifier systems are as follows.

DC Coupling: DC to 200 MHz within -3 dB, at 10 mV/div

AC Coupling: 3 Hz to 200 MHz within -3 dB, at 10 mV/div

The square wave characteristics are shown in Table 1—1 (in page 1—1).

TRIGGER AMPLIFIER

The trigger amplifier output is supplied to the A trigger and B trigger inputs in the same amplitude and opposite phase. The following adjustments are required to balance the outputs of TR208 and TR209.

- (1) First, balance the CH2 system. Adjust R283 (refer to Fig. 6—10) to balance collector outputs of TR208 and TR209 (to set same voltage).
- (2) Adjust R236 TRIG OUT LEVEL (refer to Fig. 6—10) to set DC voltage of TR208 · TR209 collector output to zero volts.
- (3) Adjust CH1 system in the same manner. Balance collector outputs of TR208 and TR209 with R295 (in Fig. 6—10), then set the DC voltage of TR208 · TR209 collector output to zero volts with R297 CH1 LEVEL (Refer to Fig. 6—10).

X5 AMPLIFIER

Set connection and controls as shown below.

CH2 OUT Connect to CH1 input through the coaxial cable BB-500.

MODE CH1

AC-GND-DC CH1 DC

CH2 AC

VOLTS/DIV 5 mV (CH1 and CH2)

VARIABLE CALIB

Connect a calibrated oscillator (CR oscillator) to the CH2 input, feed a signal exactly 5 mVp-p in amplitude and adjust R276 CH2 OUT GAIN (Fig. 6—10) to set the displayed signal amplitude to 5 divisions.

(2) After R276 is adjusted, change the control setting as follows:

AC-GND-DC CH1 DC

CH2 AC

MODE ALT

Position the CH2 trace to center of graticule by using the POSITION control, and adjust R278 CH2 OUT LEVEL so that trace of CH1 will not shift when the AC-GND-DC switch of CH1 is changed between GND and DC. (Refer to Fig. 6—10.)

Then confirm that the trace of CH1 shifts by rotating the CH2 POSITION control, after adjusting R278 and setting the CH1 AC-GND-DC switch to DC position.

A AND B TRIGGER GENERATOR

LEVEL CENTER

Set the LEVEL controls in A and B TRIGGER circuits

respectively within ± 15 degrees for DC mode or ± 5 degrees for AC mode of their mid-position (the arrow on the A control will be aligned with 0 on the panel and that of the B control to the LEVEL mark).

Feed a 1 kHz sine wave signal to the INPUT, and adjust the display amplitude to 0.5 division. Adjust R411 LEVEL CENTER (Fig. 6-2) for the A TRIGGER and adjust R711 LEVEL CENTER (Fig. 6-10) for the B TRIGGER so that the polarity of the displayed waveform will be reversed without losing synchronization when the SLOPE switch is turned from + to -, or vice versa.

TRIG STABILITY

The tunnel diode (T.D) monostable circuit is employed in this synchroscope to insure response to trigger signal of very high repetition frequency. The circuit counts down the high repetition frequency of the input trigger signal by a ratio of 1 to an integer in order to insure stable operation of the succeeding stage. The tunnel diodes are numbered D414 in the A circuit and D714 in the B circuit. (Refer to A TRIGGER GENERATOR and B TRIGGER GENERATOR on Printed Circuit Board). Adjust bias voltage so that input signal will be triggered when trigger signal being applied. (Adjustment of R476 or R776 BIAS stops triggering or changes the triggering operation into the automatic mode.)

A AND B SWEEP GENERATOR

T.D. BIAS

The T.D bias control determines the operating point of

the A and B sweep generator. Adjust R502 for the A circuit and R802 for the B circuit in the following manner.

(1) A Sweep Generator

When the trigger signal is not present, the triggering may be stopped or changed in the AUTO mode. Adjust R502 T.D bias (Fig. 6-2) until the triggering starts when a triggering signal is applied and stops when the signal is removed.

(2) B Sweep Generator

Adjustment of this circuit is identical to that of the circuit A, except that the variable resistor to be used is R802 T.D bias (Fig. 6-2).

STABILITY

The display should sweep only once (single sweep) when a trigger signal is applied after setting the MODE switch to the SINGLE position, depressing the RESET button, and the triggering circuit being set properly for triggering. If single triggering is not obtained when the RESET button is depressed or sweep continues after the MODE switch is set to the SINGLE position, adjust R548 STABILITY (Fig. 6-2) to change bias voltage for A Sweep Generator and to obtain the proper single sweep operation.

A SWEEP TIME

Set the controls as shown below.

HORIZ DISPLAY	A
A TIME/DIV	1 msec
A VARIABLE	CALIB position
MODE	NORM

SLOPE +
 COUPLING AC or DC
 SOURCE CH1

Connect a marker generator, accuracy 0.1 % or better, to the CH1 INPUT connector and apply a 1 msec markers and trigger the sweep.

The marker signals must be displayed at each vertical division of graticule. Check that accuracy is maintained within $\pm 3\%$ in all ranges of the A TIME/DIV switch. Change the marker frequency and the TIME/DIV switch setting simultaneously.

- (1) If the accuracy of the A TIME/DIV switch is worse than $\pm 3\%$, adjust R633 A SWEEP ADJ (Fig. 6-10). Also check accuracy of the B TIME/DIV switch by

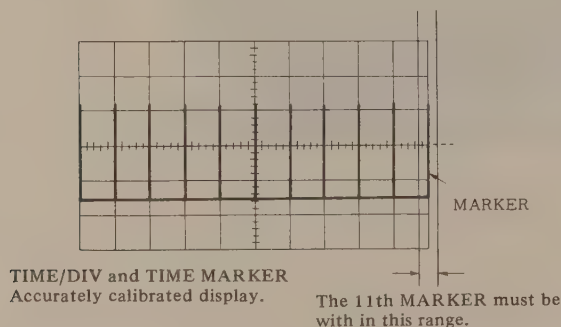
turning the HORIZ DISPLAY switch to the DLY'D (B) position.

- (2) If the sweep time error exceeds $\pm 3\%$ in both the A and B circuits, adjust R1061 NORM GAIN (Fig. 6-2).

X 10 MAG

After the calibration of a TIME/DIV switch is completed, pull the FINE switch to magnify the display. The display must be magnified exactly 10 times. If not, adjust R1051 MAG GAIN (in Fig. 6-2).

Figure 6-8 TIME/DIV calibration



MAG CENTER

This adjustment is to ensure that the center part of the display is magnified when the FINE control is set from the PUSH NORMAL position to PULL x10 MAG position.

Set the starting point of the magnified display to the vertical center line of the graticule by adjusting the POSITION control, and change the FINE control to the PUSH normal position. Adjust the starting point of the display to the vertical center line with R1070 MAG CENTER (Fig. 6-2).

B SWEEP TIME

Adjustment of B sweep time is identical to the A SWEEP TIME calibration.

Figure 6-9 Left side view

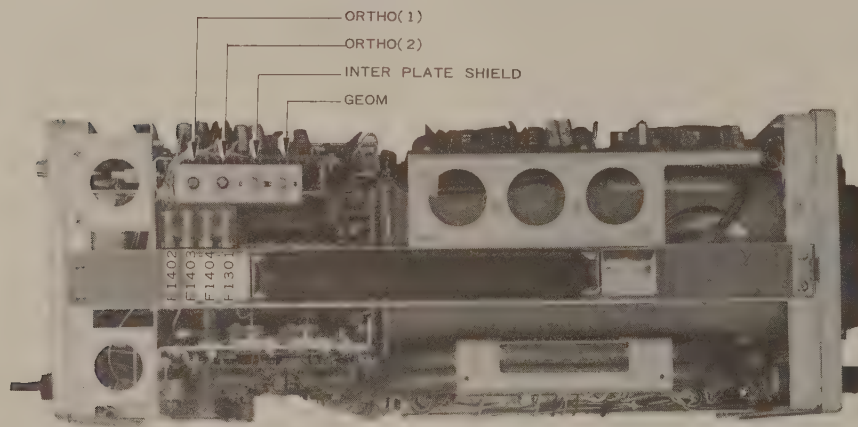
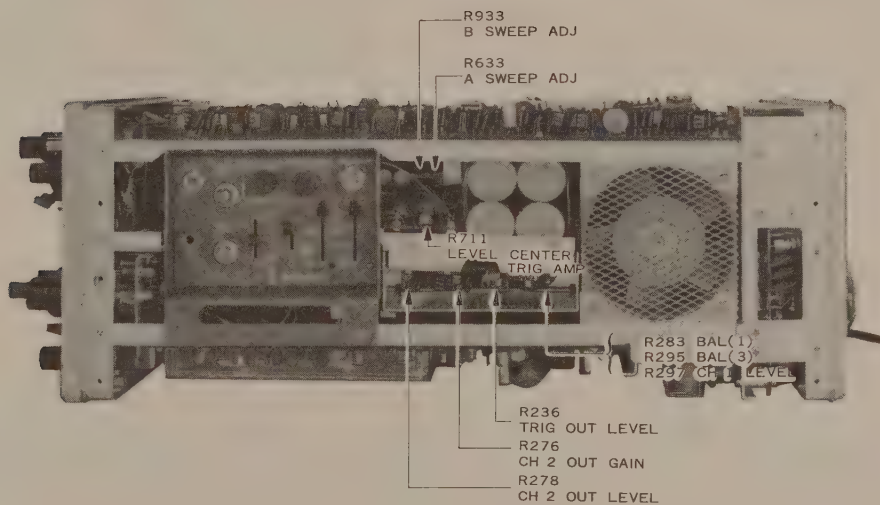


Figure 6—10 Right side view



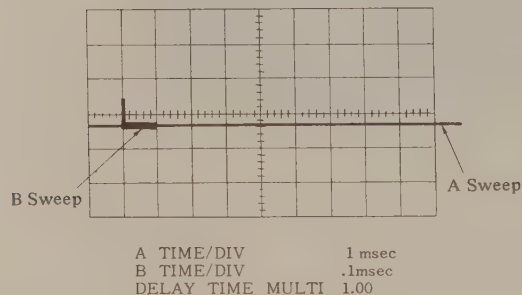
Set the controls to the following positions.

HORIZ DISPLAY DLY'D (B)
 B TIME/DIV 1 msec
 B VARIABLE CALIB position
 SLOPE (for B) +
 COUPLING (B) AC or DC
 SOURCE (B) CH1

Connect a 1 msec signal from the TIME MARKER to the CH1 INPUT. The marker signals must be displayed at each vertical line of the graticule. Similar to the A TIME/DIV calibration, change the marker frequency and setting of the B TIME/DIV switch simultaneously to check that accuracy within $\pm 3\%$ is maintained in all switch positions.

When only the B TIME/DIV switch is out of calibration, adjust R933 B SWEEP ADJ (Fig. 6-10).

Figure 6-11 Calibration of START ADJ



If both the B TIME/DIV and A TIME/DIV are equally erroneous, calibrate the R1061 as described previously.

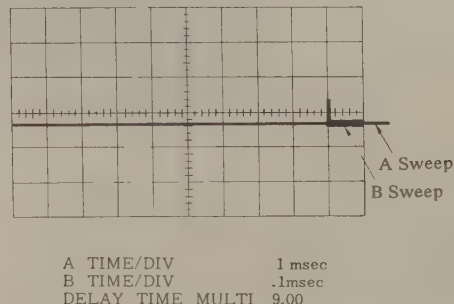
Reference

The sweep time accuracy may be checked by using a stop watch. Set the A TIME/DIV or B TIME/DIV switch to .5 sec range, start auto sweep, and count the time required for the spot to sweep 10 divisions on the graticule. The time to sweep 10 divisions must be 5 sec.

DELAY TIME MULTI

The DELAY TIME MULTI must be calibrated after the

Fig. 6-12 Calibration of STOP ADJ



A and B TIME/DIV calibration is completed. Set the controls as shown below.

A TIME/DIV	1 msec
B TIME/DIV	.1 msec
A-B VARIABLE	CALIB
HORIZONTAL DISPLAY	A INT BY B
MODE	AUTO (Free Running)
B TRIG LEVEL	PUSH (Free Running)

- (1) Adjust the starting point of A SWEEP to the leftmost end of the graticule, and set the DELAY TIME MULTI potentiometer to 1.00. Adjust R878 START ADJ (Fig. 6-2) to set starting point of the intensified part (the part must be 1 division in length) to the first vertical scale of the graticule. (Refer to Fig. 6-11).

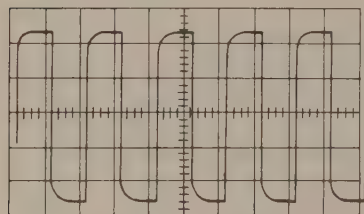
- (2) Change the DELAY TIME MULTI potentiometer to 9.00, similarly adjust R880 STOP ADJ (Fig. 6-2) so that the intensified part will start from the 9th vertical scale from the starting of A sweep. (Refer to Fig. 6-12). Repeat the adjustments (1) and (2) until both are correct.

CALIBRATOR

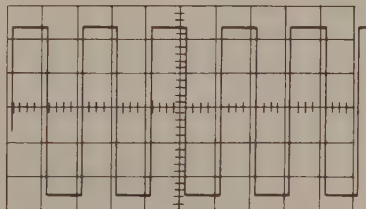
CAL OUTPUT VOLTAGE

After the adjustment of the vertical axis sensitivity is completed connect the vertical INPUT or this synchro-

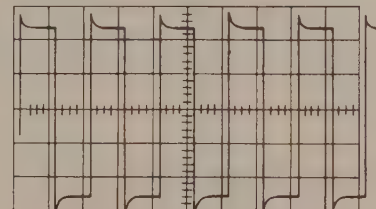
Figure 6-13 Probe compensation waveform



Insufficient compensation



Correct compensation



Excessive compensation

scope, or of the other calibrated synchroscope to the CAL OUT connector.

Set the CAL switch to the 0.2 V range, and change the VOLTS/DIV switch to 50 mV/DIV. The amplitude of the displayed CAL signal should be 2.5 div. If it deviates by more than 2 % of 2.5 divisions, adjust R1501 CAL ADJ (Fig. 6-3).

CAL FREQUENCY

An electronic counter is preferable for calibration of the CAL frequency; however, it may be calibrated in the following manner.

HORIZ DISPLAY	A
A TIME/DIV	1 msec
A VARIABLE	CALIB
SOURCE	EXT

Connect the CAL OUT to INPUT and feed a 1 msec time marker signal to the TRIG INPUT (A SWEEP circuit). Adjust T1501 (Fig. 6-3) so that the CAL waveform moves slower than 5 divisions per second. The CAL frequency is changed by turning the metallic disc located on the transformer core.

PROBE CALIBRATION

If the pulse and/or high frequency characteristics of probe are not correct, erroneous waveform measurement will result. The phase and high frequency characteristics are calibrated in the following procedures.

PROBE COMPENSATION

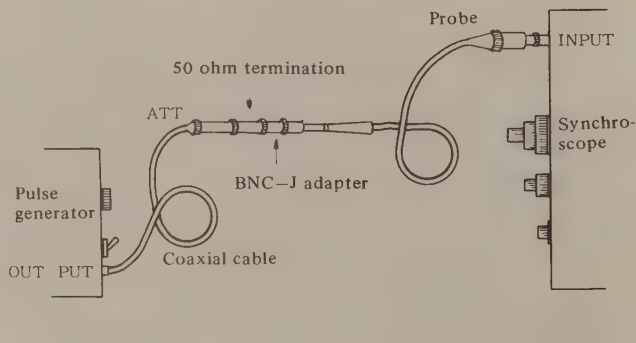
Connect the connector of probe to INPUT and connect the probe tip, after removing the retractable hook tip to the CAL OUT. Set the VOLTS/DIV switch to the 10 mV and the CAL switch to the 0.2 V range. The vertical amplitude of display should be 2 divisions.

By turning the variable capacitor shown in Fig. 3-6, the displayed waveform will change as shown in Fig. 6-13. Set the variable capacitor to the correct waveform.

HIGH FREQUENCY COMPENSATION

The following test instruments and adapter must be

Figure 6-14 Connection of probe to pulse generator



prepared.

- | | |
|-----------------------------------|--|
| 1. Pulse generator | Rise time 300 ps or better
Output voltage 0 to 1 volt |
| 2. Coaxial cable | 50 Ω |
| 3. 50 Ω termination | BB50M1 |
| 4. BNC-J adapter | (will be described later) |
| 5. 50 Ω coaxial attenuator | (will be described later) |

After the probe compensation is completed, remove the compensating box cover and connect the probe to the pulse generator as shown in Fig. 6–14.

Calibration procedures

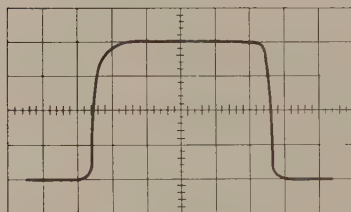
1. Set the VOLTS/DIV switch to the 10 mV position and adjust the A TIME/DIV switch so that 1 or 2 cycle of the

squarewave will be displayed although the switch position depends on repetition frequency and pulse width of the squarewave generator.

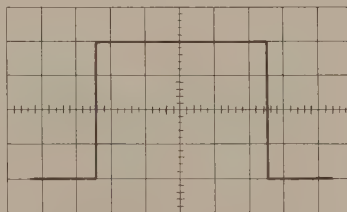
2. Adjust the squarewave generator output to set the display to 4 to 5 divisions in amplitude. If the generator output is excessively large, it may be attenuated by using the 50 Ω coaxial attenuator (AA series). Use of the BNC-J adapter will facilitate to hold the probe tip tight and aid adjustment. (A test jack is prepared to connect ground of the probe firm to the chassis to increase accuracy in high frequency waveform measurement.)

3. Adjust R2 (Fig. 6–16) to make top of waveforms flat as shown in Fig. 6–15 (b), and adjust R3 and R4 (Fig. 6–16) to obtain a square corner on waveforms. Overshoot, undershoot or ringing shown in Fig. 6–15 (c) must be

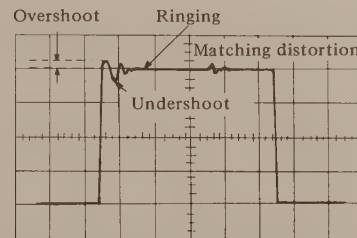
Figure 6–15 High frequency square wave characteristics



(a) Rounded leading edge



(b) Correctly compensated waveform

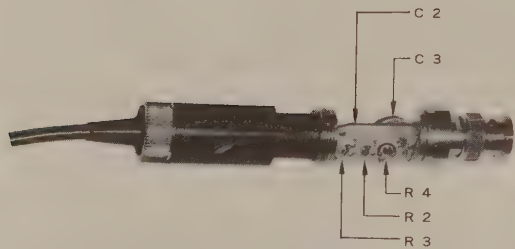


(c) Excessive distortion

removed.

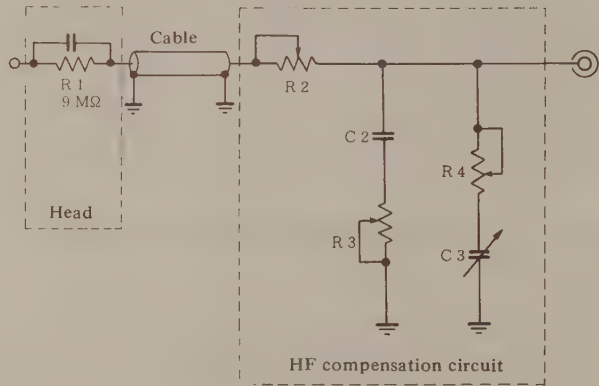
Readjust R2, R3 and R4 to obtain the best possible flat-top and front corner of the waveforms.

Figure 6-16 1020 PROBE COMPENSATING BOX



An insulated (plastic blade) screwdriver must be used for the probe compensation and high frequency compensation to prevent induction of hum in the adjustment.

Figure 6-17 COMPENSATING CIRCUIT OF 1020 PROBE



MEMO

CHAPTER 7 PARTS LIST

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ORDERING INFORMATION

Replacement parts may be ordered through an IWATSU Representative or directly from the factory. To be certain of receiving the proper parts, always include the following information with the order:

- a. Model Number and serial number of the instrument on which the parts will be installed.
- b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
- c. Iwatsu part number.

For factory repair, contact the IWATSU agent and include the following information:

- a. Model number and serial number of the instrument on which the work is to be performed.
- b. Details concerning the nature of the malfunction: or, type of repair desired.

Shipping instruction will be sent to you promptly;

HOW TO USE THIS PARTS LIST

The parts list is divided into subsections corresponding to the schematic diagrams such as VERTICAL AMP, TRIG CIRCUIT, SWEEP GENERATOR, HORIZONTAL AMP, CRT CIRCUIT and POWER SUPPLY. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the

beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

ABBREVIATIONS

Cap.	Capacitor			
cer	ceramic			
elect.	aluminium	electrolytic	chemical	con-
	denser			
elect. tan ...	tan-talum	electrolytic	chemical	con-
	denser			
poly.	polyethytel film	condenser		
	mica condenser			
Res.	Resistor			
w.w.	wire wound			
compo.	composition			
	carbon			
	metal			

The symbol of Ω (ohm) is omitted.

Tr.	Transistor
FET	Field Effect Transistor

Diode	
T. Diode ...	Tunnel Diode
Z. Diode ...	Zenner Diode

L	coil
var.	variable

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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ATTENUATOR

CAPACITORS

C1 A·B	Cap., 5 pF ± 0.5 pF, 50 WVDC, cer.	74 050 262 0
C2 A·B	Cap., 0.047 μ F ± 20 %, 400 WVDC, poly.	74 130 331 0
C4 A·B	Cap., 0.5 pF — 4 pF val., 250 WVDC, cer.	74 110 090 0
C5 A·B	Cap., 6 pF ± 0.5 pF, 500 WVDC, cer.	74 050 6090
C6 A·B	Cap., 0.5 pF — 4 pF, val., 500 WVDC, cer.	74 110 030 0
C7 A·B	Same as C4 A·B	
C8 A·B	Same as C6 A·B	
C9 A·B	Same as C4 A·B	
C10 A·B	Cap., 0.5 pF — 1.5 pF val., 500 WVDC, cer.	74 110 029 0
C11 A·B	Same as C4 A·B	
C12 A·B	Same as C10 A·B	
C13 A·B	Same as C4 A·B	
C14 A·B	Same as C10 A·B	
C15 A·B	Same as C4 A·B	
C16 A·B	Same as C10 A·B	
C17 A·B	Same as C4 A·B	
C18 A·B	Same as C10 A·B	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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C19 A·B	Same as C4 A·B	
C20 A·B	Same as C10 A·B	
C21 A·B	Cap., 20 pF ± 10 %, 500 WVDC, mica	74 090 501 0
C22 A·B	Same as C21 A·B	
C23 A·B	Cap., 50 pF ± 10 %, 500 WVDC, mica	74 090 502 0
C24 A·B	Cap., 100 pF ± 10 %, 500 WVDC, mica	74 090 503 0
C25 A·B	Cap., 200 pF ± 10 %, 500 WVDC, mica	74 090 504 0
C26 A·B	Cap., 500 pF ± 10 %, 500 WVDC, mica	24 090 505 0
C27 A·B	Cap., 3 pF ± 0.5 pF, 500 WVDC, cer.	74 050 605 0
C28 A·B	Cap., 0.001 μ F -0 — +100 %, 500 WVDC, cer.	74 060 018 0
C29 A·B	Cap., 56 pF ± 10 %, 500 WVDC, cer.	74 050 610 0
C30 A·B	Cap., 6 pF — 20 pF val., 250 WVDC, cer.	74 110 063 0
Ca1 A·B	Same as C28 A·B	
Ca2 A·B	Cap., 2 pF ± 0.5 pF, 50 WVDC, cer.	74 050 169 0
Ca3 A·B	Same as Ca2 A·B	
Ca4 A·B	Cap., 4 pF ± 0.5 pF, 50 WVDC, cer.	74 050 472 0
Ca5 A·B	Same as Ca4 A·B	
Ca6 A·B	Same as C28 A·B	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
COILS		
L1 A·B	Inductor	74 400 488 0
L2 A·B	Inductor	74 400 489 0
L3 A·B	Inductor (Ferrite Bead Core)	74 560 124 0
	L82 OP 03-03 1H	
L4 A·B	Same as L3 A·B	
L5 A·B	Same as L3 A·B	

RESISTORS

R1 A·B	Res., $82 \pm 2 \%$, 1/4 W, carbon	74 244 056 0
R2 A·B	Res., $10 \pm 5 \%$, 1/8 W, compo.	74 257 002 0
R3 A·B	Res., $100 k \pm 2 \%$, 1/4 W, carbon	74 244 018 0
R4 A·B	Res., $900 k \pm 1 \%$, 1/4 W, carbon	74 226 010 0
R5 A·B	Res., $500 k \pm 1 \%$, 1/4 W, carbon	74 226 008 0
R6 A·B	Res., $1 M \pm 1 \%$, 1/4 W, carbon	74 226 015 0
R7 A·B	Res., $62 \pm 5 \%$, 1/8 W, compo.	74 257 001 0
R8 A·B	Res., $800 k \pm 1 \%$, 1/4 W, carbon	74 226 009 0
R9 A·B	Res., $250 k \pm 1 \%$, 1/4 W, carbon	74 226 007 0
R10 A·B	Res., $82 \pm 5 \%$, 1/8 W, compo.	74 257 088 0
	Res., $91 \pm 5 \%$, 1/8 W,	74 257 087 0
	(for adjustment) carbon	
	Res., $100 \pm 5 \%$, 1/8 W,	74 257 070 0
	(for adjustment) carbon	
R11 A·B	Same as R4 A·B	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R12 A·B	Res., $111 k \pm 1 \%$, 1/4 W, carbon	74 226 006 0
R13 A·B	Res., $68 \pm 5 \%$, 1/8 W, compo.	74 257 079 0
R14 A·B	$950 k \pm 1 \%$, 1/4 W, carbon	74 226 011 0
R15 A·B	Res., $52.6 k \pm 1 \%$, 1/4 W, carbon	74 226 005 0
R16 A·B	Same as R13 A·B	
R17 A·B	Res., $980 k \pm 1 \%$, 1/4 W, carbon	74 226 012 0
R18 A·B	Res., $20.4 k \pm 1 \%$, 1/4 W, carbon	74 226 004 0
R19 A·B	Res., $75 \pm 5 \%$, 1/8 W, compo.	74 257 080 0
R20 A·B	Res., $990 k \pm 1 \%$, 1/4 W, carbon	74 226 013 0
R21 A·B	Res., $10.1 k \pm 1 \%$, 1/4 W, carbon	74 226 003 0
R22 A·B	Same as R19 A·B	
R23 A·B	Res., $995 k \pm 1 \%$, 1/4 W, carbon	74 226 014 0
R24 A·B	Res., $5.03 k \pm 1 \%$, 1/4 W, carbon	74 226 002 0
R25 A·B	Same as R7 A·B	
R26 A·B	$990 k \pm 1 \%$, 1/4 W, carbon	74 226 179 0
R27 A·B	Res., $2 k \pm 1 \%$, 1/4 W, carbon	74 226 219 0
R28 A·B	Res., $47 \pm 5 \%$, 1/8 W, compo	74 257 014 0
R29 A·B	Res., $470 k \pm 2 \%$, 1/2 W, carbon	74 241 105 0
R30 A·B	Same as R2 A·B	

SWITCHES

S1 A·B	Lever Switch, LS15H1-2-3 (CH1 ·CH2 AC-GND-DC)	74 440 152 0
S2 A·B	Rotary Switch, S15H(12)4-8-10 (CH1 ·CH2 VOLTS/DIV)	74 431 624 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
CONNECTOR		
J1 A-B	BNC Connector, UG-625/U-Ni (CH1 - CH2 INPUT)	74 500 253 0

 VERTICAL PRE-AMPLIFIER

CAPACITORS

C31	Cap., 0.002 μ F -20 - +80 %, 50 WVDC, cer.	74 060 158 0
C32	Same as C31	
C33	Cap., 33 μ F $\pm$ 20 %, 16 WVDC, elect.	74 120 148 0
C34	Same as C31	
C35	Same as C31	
C36	Cap., 3 pF - 10 pF var., 50 WVDC, cer.	74 110 075 0
C37	Same as C31	
C38	Same as C31	
C39	Cap., 6 pF $\pm$ 1 %, 50 WVDC, cer.	74 050 598 0
C40	Same as C39	
C41	Same as C31	
C42	Same as C31	
C43	Same as C36	
C44	Same as C31	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C45	Same as C31	
C46	Same as C36	
C48	Same as C31	
C49	Same as C31	
C50	Same as C31	
C51	Same as C31	
C52	Same as C31	
C53	Same as C31	
C54	Same as C31	
C55	Cap., 0.5 pF - 1.5 pF var., 500 WVDC, cer.	74 110 029 0
C56	Same as C31	
C57	Same as C31	
C58	Same as C33	
C59	Same as C31	
C60	Same as C31	
C61	Same as C36	
C62	Same as C31	
C63	Same as C31	
C64	Same as C39	
C65	Same as C39	
C66	Same as C31	
C67	Same as C31	
C68	Same as C36	
C69	Same as C31	
C70	Same as C31	
C71	Same as C36	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C72	Same as C31	
C73	Same as C31	
C74	Same as C31	
C75	Same as C31	
C76	Same as C55	
C80	Cap., 68 μ F ± 20 %, 16 WVDC, elect-tan.	74 120 250 0
C81	Same as C80	
C82	Same as C80	
C83	Same as C80	
C85	Cap., 8 pF ± 0.5 pF, 50 WVDC, cer.	74 050 560 0
C86	Same as C85	
C87	Cap., 5 pF — 20 pF var., 50 WVDC, cer.	74 110 078 0
C88	Same as C87	
C90	Cap., 0.001 μ F -20 — +80 %, 50 WVDC, cer.	74 060 175 0
C91	Same as C90	
C92	Same as C90	
C93	Same as C90	
C94	Cap., 0.001 μ F -0 — +100 %, 500 WVDC, cer.	74 060 070 0
C95	Same as C94	
C96	Same as C90	
C97	Same as C90	
C98	Same as C90	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C99	Same as C90	
C100	Cap., 0.001 μ F -0 — +100 %, 250 WVDC, cer.	74 060 018 0
COILS		
L31	RF Inductor LT-A-10	74 560 126 0
L32	Same as L31	
L33	Same as L31	
L34	Same as L31	
L35	Inductor, Coil 6T	74 400 490 0
L36	Same as L35	
L37	Inductor, Coil 3T + 3T	74 400 491 0
L38	Same as L37	
L39	Inductor (Ferrite Bead Core) L82 OP 03-03 1H	74 560 124 0
L40	Same as L39	
L41	Same as L37	
L42	Same as L37	
L43	Same as L39	
L44	Same as L39	
L45	Same as L35	
L47	Same as L35	
L48	Same as L37	
L49	Same as L37	
L50	Same as L39	
L51	Same as L39	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
L52	Same as L39	
L53	Same as L39	
L54	Same as L37	
L55	Same as L37	
L56	Same as L35	
L57	Same as L35	

RESISTORS

R31	Res., 4.7 k $\pm 5\%$, 1/4 W, metal	74 230 029 0
R31b	Res., 100 $\pm 2\%$, 1/2 W, carbon	74 242 020 0
R32	Res., 2.4 k $\pm 5\%$, 1/4 W, metal	74 230 022 0
R32b	Res., 82 $\pm 5\%$, 1/4 W, metal	74 230 107 0
R33	Res., B2 k var., (CH1 DC Bal)	74 349 088 0
	0.1 W, carbon	
R34	Res., 3.9 k $\pm 5\%$, 1/4 W, metal	74 230 009 0
R35	Res., 2 k $\pm 5\%$, 1/4 W, metal	74 230 041 0
R36	Res., 620 $\pm 5\%$, 1/4 W, metal	74 230 104 0
R37	Res., 470 $\pm 5\%$, 1/4 W, metal	74 230 016 0
R38	Res., 5.1 k $\pm 5\%$, 1/4 W, metal	74 230 102 0
R39	Same as R38	
R40	Res., 47 $\pm 5\%$, 1/4 W, metal	74 230 010 0
R42	Res., 10 $\pm 5\%$, 1/4 W, metal	74 230 007 0
R43	Res., 390 $\pm 5\%$, 1/4 W, metal	74 230 055 0
R45	Same as R42	
R46	Same as R34	
R47	Same as R34	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R50	Res., 10 $\pm 5\%$, 1/4 W, compo.	74 253 044 0
R51	Same as R50	
R52	Res., B200 var., 0.1 W, metal	74 349 077 0
R53	Res., 100 $\pm 5\%$, 1/4 W, metal	74 230 013 0
R54	Res., 1 k $\pm 5\%$, 1/4 W, metal	74 230 103 0
R55	Same as R54	
R56	Res., 750 $\pm 5\%$, 1/4 W, metal	74 230 054 0
R57	Same as R56	
R58	Same as R52 (CH1 5 mV Gain)	
R59	Same as R53	
R60	Same as R53	
R61	Same as R54	
R62	Same as R54	
R63	Res., 43 $\pm 5\%$, 1/4 W, metal	74 230 122 0
R64	Same as R63	
R65	Same as R54	
R66	Same as R56	
R67	Res., B2 k var., (CH1 VARIABLE),	74 322 232 0
	0.1 W, carbon	
R68	Res., 1.5 k $\pm 5\%$, 1/4 W, metal	74 230 011 0
R69	Same as R52 (CH1 VARIABLE Adj)	
R70	Res., 3 k $\pm 5\%$, 1/4 W, metal	74 230 053 0
R71	Same as R68	
R72	Same as R53	
R73	Same as R53	
R74	Res., 130 $\pm 5\%$, 1/4 W, metal	74 230 115 0
R75	Res., 91 $\pm 5\%$, 1/4 W, metal	74 230 123 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R76	Same as R75	
R77	Res., $51 \pm 5 \%$, 1/4 W, metal	74 230 060 0
R78	Same as R77	
R79	Same as R50	
R80	Same as R50	
R81	Same as R52	
R82	Res., $120 \pm 5 \%$, 1/4 W, metal	74 230 113 0
R83	Same as R53	
R84	Res., $360 \pm 5 \%$, 1/4 W, metal	74 230 111 0
R85	Same as R84	
R86	Same as R53	
R87	Same as R82	
R88	Same as R82	
R89	Res., $160 \pm 5 \%$, 1/4 W, metal	74 230 141 0
R90	Res., $3.6 k \pm 5 \%$, 1/4 W, metal	74 230 108 0
R91	Same as R90	
R92	Same as R45	
R93	Same as R45	
R94	Same as R52	
R95	Res., B100, Var., (CH1 5 mV Gain), 0.1 W, metal	74 349 083 0
R96	Same as R77	
R97	Res., $1.6 k \pm 5 \%$, 1/4 W, metal	74 230 132 0
R98	Same as R97	
R99	Res., B1 k var., (CH1 Pos Range), 0.1 W, selected carbon	74 349 064 0
R100	Res., $220 \pm 5 \%$, 1/4 W, metal	74 230 048 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R101	Same as R100	
R102	Res., $18 \pm 5 \%$, 1/4 W, compo.	74 253 068 0
R103	Same as R102	
R104	Res., $9.1 k \pm 5 \%$, 1/4 W, metal	74 230 109 0
R105	Same as R104	
R106	Res., B10 k x 2 (CH1 POSITION), 0.1 W, selected carbon	74 322 180 0
R107	Res., $1.8 k \pm 5 \%$, 1/4 W, metal	74 230 081 0
R108	Same as R107	
R109	Res., $300 \pm 5 \%$, 1/4 W, metal	74 230 116 0
R110	Same as R109	
R111	Same as R107	
R112	Same as R107	
R113	Res., $580 \pm 5 \%$, 5 W, W.W.	74 291 105 0
R114	Res., $180 \pm 5 \%$, 1/4 W, metal	74 230 086 0
R115	Res., $470 \pm 2 \%$, 1 W, carbon	74 242 022 0
R116	Same as R115	
R117	Same as R114	
R118	Res., $390 \pm 2 \%$, 1 W, carbon	74 242 020 0
R119	Same as R31	
R120	Same as R32	
R120b	Same as R32b	
R121	Same as R33 (CH2 DC Bal)	
R122	Same as R34	
R123	Same as R35	
R124	Same as R36	
R125	Same as R37	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R126	Same as R38	
R127	Same as R38	
R128	Same as R40	
R129	Same as R56	
R130	Same as R43	
R131	Same as R42	
R132	Same as R42	
R133	Same as R34	
R134	Same as R34	
R135	Same as R50	
R136	Same as R50	
R137	Same as R52	
R138	Same as R53	
R139	Same as R54	
R140	Same as R54	
R141	Same as R56	
R142	Same as R52	
R143	Same as R53	
R144	Same as R53	
R145	Same as R54	
R146	Same as R54	
R147	Same as R56	
R148	Same as R54	
R149	Same as R67 (CH2 VARIABLE)	
R150	Same as R68	
R151	Same as R63	
R152	Same as R63	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R153	Same as R52 (CH2 VARIABLE Adj)	
R154	Same as R70	
R155	Same as R68	
R156	Same as R53	
R157	Same as R53	
R158	Same as R74	
R159	Same as R75	
R160	Same as R75	
R161	Same as R77	
R162	Same as R77	
R163	Same as R50	
R163a	Same as R79	
R164a	Same as R79	
R165	Same as R52	
R166	Same as R82	
R167	Res., 270 $\pm$ 5 %, 1/4 W, metal	74 230 091 0
R168	Same as R167	
R169	Same as R53	
R170	Same as R53	
R171	Same as R82	
R172	Same as R82	
R173	Same as R82	
R174	Same as R82	
R175	Same as R90	
R176	Same as R90	
R178	Same as R52 (CH2 5 mV Gain)	
R179	Same as R95 (CH2 Gain)	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R180	Same as R77	
R181	Same as R97	
R182	Same as R97	
R183	Same as R99 (CH2 Pos Range)	
R184	Same as R100	
R185	Same as R100	
R186	Same as R102	
R187	Same as R102	
R188	Same as R104	
R189	Same as R104	
R190	Same as R106 (CH2 POSITION)	
R192	Same as R89	
R193	Same as R40	
R194	Same as R40	
R195	Same as R52	
R196	Res., B500 var., (CH2 Att Bal), 0.1 W, metal	74 349 076 0
R197	Same as R196 (CH1 Att Bal)	
R198	Same as R42	
R199	Same as R42	
DIODES		
D31	Z. Diode RD6A	74 040 079 0
D32	Same as D31	
D33	Diode, 1S1458	74 040 292 0
D34	Same as D33	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D35	Diode 1S1992	74 036 043 0
D36	Same as D35	
D37	Same as D33	
D38	Same as D33	
D39	Same as D33	
D40	Same as D33	
D41	Same as D31	
D42	Same as D31	
D43	Same as D33	
D44	Same as D33	
D45	Same as D35	
D46	Same as D35	
D47	Same as D33	
D48	Same as D33	
D49	Same as D33	
D50	Same as D33	
D51	Same as D33	
D52	Same as D33	
D53	Same as D33	
D54	Same as D33	
D55	Same as D33	
D56	Same as D33	
D57	Same as D33	
D58	Same as D33	

TRANSISTORS

TR31	Transistor 2SJ12	74 030 324 0
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CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TR32	Transistor TIS27	74 030 281 0
TR33	Transistor N501BFY	74 036 035 0
TR34	Transistor 2N3571	74 036 028 0
TR35	Same as TR34	
TR36	Same as TR34	
TR37	Same as TR34	
TR38	Transistor 2N4957	74 036 050 0
TR39	Same as TR38	
TR40	Same as TR34	
TR41	Same as TR34	
TR42	Same as TR34	
TR43	Same as TR34	
TR44	Same as TR32	
TR45	Same as TR33	
TR46	Same as TR34	
TR47	Same as TR34	
TR48	Same as TR34	
TR49	Same as TR34	
TR50	Same as TR38	
TR51	Same as TR38	
TR52	Same as TR34	
TR53	Same as TR34	
TR54	Same as TR31	

NEON LAMPS

NE31	Neon Lamp NE-2 (CH1 UNCALIB)	74 020 111 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
NE32	Same as NE31 (CH2 UNCALIB)	
	Socket of Neon Lamp Type C	74 480 149 0

SWITCH

S31 a-b	Rotary Switch (MODE · CH2 POLARITY)	74 431 625 0
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CONNECTORS

J31	Connector 27-15	74 500 390 0
J32	Same as J31	
J33	Same as J31	
J34	Same as J31	
J151	Connector 143-015-01 TYPE 143	74 500 190 0

P31	Connector 27-18	74 500 369 0
P32	Same as P31	
P33	Same as P31	
P34	Same as P31	

HEAT DISSIPATOR

	Semiconductor Heat Dissipator TXBF-019-025	74 030 258 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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THERMO CASE

	Thermo case Type 46	7 66 6022 70
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TOROIDAL TRANS

T31	Troidal Trans	74 400 285 0
T32	Same as T31	

VERTICAL SWITCHING CIRCUIT

CAPACITORS

C151	Cap., 0.0022 μ F ± 10 %, 50 WVDC, poly.	24 130 196 0
C152	Cap., 0.1 μ F -20 — +80 %, 25 WVDC, cer.	74 060 233 0
C153	Cap., 33 μ F ± 20 %, 25 WVDC, elect. tan	74 120 405 0
C154	Cap., 100 pF ± 10 %, 50 WVDC, cer.	74 050 171 0
C155	Cap., 0.001 μ F -0 — +100 %, 500 WVDC, cer.	74 060 070 0
C156	Cap., 10 μ F ± 20 %, 16 WVDC, elect. tan	74 120 186 0
C157	Cap., 47 pF -20 — +80 %, 50 WVDC, cer.	74 050 273 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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C158	Same as C157	
C159	Same as C157	
C160	Same as C157	
C161	Same as C155	

COILS

L151	RF Inductor LT-A-10	74 560 126 0
L152	Inductor (Ferrite Bead Core) L82 OP 03-03 1H	74 560 124 0
L153	Same as L152	
L154	Same as L152	
L155	Same as L152	

RESISTORS

R151b	Res., 120 ± 5 %, 1/4 W, metal	74 230 113 0
R152b	Same as R151b	
R153b	Res., 1 k ± 5 %, 1/4 W, metal	74 230 003 0
R154b	Same as R153b	
R155b	Same as R153b	
R156b	Same as R153b	
R157b	Res., 20 ± 5 %, 1/4 W, metal	74 230 114 0
R158b	Same as R157b	
R159b	Same as R153b	
R160b	Same as R153b	
R161b	Res., 3.3 k ± 5 %, 1/4 W, metal	74 230 035 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R162b	Res., 1.8 k $\pm$ 5 %, 1/4 W, metal	74 230 081 0
R163b	Same as R162b	
R164b	Res., 160 $\pm$ 5 %, 1/4 W, metal	74 230 141 0
R165b	Same as R164b	
R166b	Res., 56 $\pm$ 5 %, 1/4 W, metal	74 230 094 0
R167b	Same as R153b	
R168b	Res., 3.6 k $\pm$ 5 %, 1/4 W, metal	74 230 108 0
R169b	Res., 560 $\pm$ 5 %, 1/4 W, metal	74 230 058 0
R170b	Res., 2.4 k $\pm$ 5 %, 1/4 W, metal	74 230 022 0
R171b	Res., 100 k $\pm$ 5 %, 1/4 W, metal	74 230 026 0
R172b	Res., 20 k $\pm$ 5 %, 1/4 W, metal	74 230 031 0
R173b	Res., 47 $\pm$ 5 %, 1/4 W, metal	74 230 010 0
R174b	Same as R162b	
R177b	Res., 2.4 k $\pm$ 2 %, 2 W, carbon	74 243 042 0
R178b	Res., 2 k $\pm$ 2 %, 2 W, carbon	74 243 040 0
R179b	Res., 10 $\pm$ 2 %, 1/2 W, carbon	74 241 001 0
R180b	Same as R179b	

DIODES

D151	Diode 1S953	74 040 172 0
D152	Same as D151	
D153	Same as D151	
D154	Same as D151	
D155	Same as D151	
D156	Same as D151	
D157	Same as D151	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D158	Same as D151	
D159	Z. Diode HW18B	74 040 349 0

TRANSISTORS

TR151	Transistor 2N4258	74 030 315 0
TR152	Same as TR151	
TR153	Transistor 2N4121	74 030 299 0
TR154	Transistor 2N4275	74 030 316 0
TR155	Same as TR151	

TRANSFORMER

T151	Pulse Transformer	74 400 407 0
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TRIGGER AMPLIFIER

CAPACITORS

C201	Cap., 0.02 μ F -20 — +80 %, 25 WVDC, cer.	74 060 057 0
C203	Cap., 3 — 10 pF var., 50 WVDC, cer.	74 110 075 0
C206	Same as C203	
C207	Cap., 5 — 20 pF var., 50 WVDC, cer.	74 110 078 0
C208	Same as C201	
C209	Same as C201	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C210	Cap., 10 μ F ± 20 %, 16 WVDC, elect. tan	74 120 186 0
C211	Same as C201	
C213	Same as C203	
C216	Same as C203	
C217	Same as C207	
C218	Same as C201	
C219	Same as C201	
C220	Same as C210	
C221	Same as C201	
C222	Same as C207	
C223	Same as C201	
C224	Same as C201	
C225	Cap., 47 pF ± 10 %, 50 WVDC, cer.	74 050 273 0
C226	Cap., 0.001 μ F -0 — +100 %, 500 WVDC, cer.	74 060 070 0
C227	Same as C226	
C228	Same as C226	
C229	Same as C226	
C230	Same as C226	
C231	Same as C226	
C232	Same as C226	
COILS		
L201	RF Inductor LT-A-10	74 560 126 0
L202	Same as L201	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
L203	Inductor (Ferrite Bead Core), L82 OP 03-03 1H	74 560 124 0
L204	Same as L203	
L205	Same as L203	
L206	Same as L203	
L207	Inductor coil 6T	74 400 490 0
L208	Same as L207	
RESISTORS		
R201	Res., 91 ± 5 %, 1/4 W, metal	74 230 123 0
R202	Same as R201	
R203	Res., 20 ± 5 %, 1/4 W, metal	74 230 114 0
R204	Same as R203	
R205	Res., 2 k ± 5 %, 1/4 W, metal	74 230 041 0
R206	Same as R205	
R207	Res., 220 ± 5 %, 1/4 W, metal	74 230 048 0
R208	Same as R203	
R209	Same as R203	
R210	Res., 150 ± 5 %, 1/4 W, metal	74 230 051 0
R211	Res., 120 ± 5 %, 1/4 W, metal	74 230 113 0
R212	Same as R211	
R213	Res., 360 ± 5 %, 1/4 W, metal	74 230 111 0
R214	Same as R213	
R215	Res., 33 ± 5 %, 1/4 W, metal	74 230 028 0
R216	Same as R203	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R217	Same as R203	
R218	Res., $180 \pm 5 \%$, 1/4 W, metal	74 230 086 0
R219	Same as R211	
R220	Same as R211	
R221	Res., $270 \pm 5 \%$, 1/4 W, metal	74 230 091 0
R222	Same as R221	
R223	Res., $100 \pm 5 \%$, 1/4 W, metal	74 230 013 0
R224	Same as R223	
R225	Same as R215	
R226	Same as R207	
R227	Same as R207	
R228	Res., $68 \pm 5 \%$, 1/4 W, metal	74 230 105 0
R229	Same as R223	
R230	Res., $12 \text{ k} \pm 5 \%$, 1/4 W, metal	74 230 044 0
R231	Res., $470 \pm 5 \%$, 1/4 W, metal	74 230 016 0
R232	Same as R231	
R233	Res., $390 \pm 2 \%$, 2 W, carbon	74 243 026 0
R234	Same as R233	
R235	Res., $180 \pm 2 \%$, 1/2 W, carbon	74 241 026 0
R236	Res., B100 var., (Trig Out Level), 0.5 W, W.W.	74 331 059 0
R238	Same as R201	
R239	Same as R201	
R240	Same as R203	
R241	Same as R203	
R242	Same as R207	
R243	Same as R205	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R244	Same as R205	
R245	Same as R203	
R246	Same as R210	
R247	Same as R211	
R248	Same as R211	
R249	Same as R213	
R250	Same as R213	
R251	Same as R223	
R252	Same as R203	
R253	Same as R203	
R254	Same as R218	
R255	Same as R211	
R256	Same as R211	
R257	Res., $330 \pm 5 \%$, 1/4 W, metal	74 230 047 0
R258	Same as R257	
R259	Same as R223	
R261	Same as R215	
R262	Same as R215	
R263	Same as R207	
R264	Same as R207	
R265	Same as R228	
R266	Same as R203	
R267	Same as R223	
R269	Same as R223	
R270	Same as R223	
R271	Same as R207	
R272	Same as R207	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R273	Res., 510 ± 5 %, 1/4 W, metal	74 230 045 0
R274	Same as R273	
R275	Same as R203	
R276	Res., B100 var., (CH2 Out Gain), 0.1 W, W.W.	74 349 160 0
R278	Res., B10 k var., (CH2 Out Level), 0.5 W, W.W.	74 331 060 0
R279	Res., 7.5 k ± 5 %, 1/4 W, metal	74 230 057 0
R280	Res., 2.2 k ± 5 %, 1/4 W, metal	74 230 027 0
R281	Res., 51 ± 5 %, 1/4 W, metal	74 230 060 0
R283	Res., 20 k ± 5 %, 1/4 W, metal	74 230 031 0
R283a	Res., B500 var., 0.1 W, W.W.	74 349 162 0
R284	Res., 10 ± 5 %, 1/4 W, metal	74 230 007 0
R285	Same as R284	
R286	Same as R284	
R287	Same as R284	
R288	Same as R284	
R289	Same as R284	
R290	Same as R284	
R291	Res., 15 ± 5 %, 1/4 W, metal	74 230 117 0
R292	Same as R291	
R293	Same as R291	
R294	Res., 68 ± 2 %, 1/2 W, carbon	74 241 071 0
R295	Same as R283	
R296	Same as R291	
R297	Same as R276 (CH1 Level)	
R299	Same as R230	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
DIODE		
D201	Diode 1S1458	74 040 292 0
D202	Same as D201	
D203	Same as D201	
D204	Same as D201	
D205	Same as D201	
D206	Same as D201	
D207	Same as D201	
D208	Same as D201	

TRANSISTORS

TR201	Transistor μ PA 15	74 030 152 0
TR202	Transistor 2N4260	74 036 032 0
TR203	Same as TR202	
TR204	Transistor 2N5179 (RED)	74 036 048 0
TR205	Same as TR204	
TR206	Same as TR202	
TR207	Same as TR202	
TR208	Same as TR202	
TR209	Same as TR202	
TR210	Same as TR201	
TR211	Same as TR202	
TR212	Same as TR202	
TR213	Same as TR204	
TR214	Same as TR204	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R215	Same as TR202	
R216	Same as TR202	
R217	Transistor 2N4258	74 030 315 0
R218	Same as TR217	

CONNECTORS

T201	Connector 143-022-01 Type 143	74 500 107 0
T202	BNC Receptacle (CH2 OUT), UG-625 U/Ni	74 500 253 0

HEAT DISSIPATOR

Semi conductor Heat Dissipator TXBF-019-025	74 030 258 0
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THERMO CASE

Thermo Case Type 46	
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 VERTICAL MAIN-AMPLIFIER

CAPACITORS

C301	Cap., 300 pF ± 10 %, 50 WVDC, cer.	74 050 180 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C302	Same as C301	
C303	Cap., 2 pF — 20 pF var., 50 WVDC, cer.	74 110 078 0
C304	Same as C303	
C305	Same as C301	
C306	Same as C301	
C307	Same as C303	
C308	Cap., 20 pF ± 5 %, 50 WVDC, cer.	74 050 528 0
C309	Cap., 47 pF ± 10 %, 50 WVDC, cer.	74 055 273 0
C311	Same as C301	
C312	Same as C301	
C313	Cap., 0.001 μ F ± 10 %, 50 WVDC, poly.	74 130 131 0
C314	Cap., 270 pF ± 10 %, 500 WVDC, cer.	74 050 050 0
C315	Cap., 0.001 μ F -0 — +100 %, 500 WVDC, cer.	74 060 070 0
C316	Cap., 0.22 μ F ± 10 %, 50 WVDC, poly.	74 130 237 0
C317	Cap., 0.01 μ F, 150 WVDC,	
COILS		
L301	Inductor, Peaking Coil	74 400 284 0
L302	Inductor, Peaking Coil	74 400 284 0
L303	Same as L302	
L304	Deflection Coil	74 400 278 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
L305	Same as L304		R322	Same as R309	
L306	Inductor, (Ferrite Bead Core) L82 OP 03-03 1H	74 560 124 0	R323	Same as R319 (Gain Adj)	
L307	Same as L306		R324	Res., 100 k $\pm$ 5 %, 1/4 W, metal	74 230 026 0
RESISTORS			R325	Same as R324	
			R326	Res., 10 $\pm$ 5 %, 1/4 W, compo.	74 253 044 0
			R327	Res., B5 k var., (NE Bal) 0.5 W, W.W.	74 331 061 0
R302	Res., 30 $\pm$ 2 %, 1/2 W, carbon	74 241 008 0	R328	Res., 30 k $\pm$ 5 %, 1/4 W, metal	74 230 092 0
R303	Res., 10 $\pm$ 5 %, 1/4 W, metal	74 230 007 0	R329	Res., 560 $\pm$ 5 %, 4 W, W.W.	74 310 220 0
R304	Same as R303		R330	Res., 2.7 k $\pm$ 2 %, 1 W, carbon	74 242 038 0
R305	Res., 130 $\pm$ 5 %, 1/4 W, metal	74 230 115 0	R331	Same as R309	
R306	Same as R305		R332	Same as R309	
R307	Res., 220 $\pm$ 5 %, 1/4 W, metal	74 230 048 0	R333	Res., 2 k $\pm$ 2 %, 2 W, carbon	74 243 040 0
R308	Same as R307		R334	Same as R333	
R309	Res., 100 $\pm$ 5 %, 1/4 W, metal	74 230 013 0	R335	Res., 510 $\pm$ 5 %, 4 W, W.W.	74 310 029 0
R310	Res., 1.5 k $\pm$ 2 %, 1/2 W, carbon	74 241 046 0	R336	Same as R335	
R311	Same as R310		R337	Res., 82 $\pm$ 5 %, 1/4 W, metal	74 230 107 0
R312	Res., B10 k var., 0.1 W, metal	74 349 091 0	R338	Same as R312	
R313	Res., 560 $\pm$ 2 %, 1/2 W, carbon	74 241 038 0	R339	Res., B200 var., 0.1 W, metal	74 349 077 0
R314	Res., 620 $\pm$ 5 %, 5 W, W.W.	74 291 098 0	R340	Res., 680 $\pm$ 5 %, 1/4 W, metal	74 230 015 0
R315	Res., 180 $\pm$ 5 %, 1/4 W, metal	74 230 086 0	R341	Res., 91 $\pm$ 2 %, 2 W, carbon	74 243 103 0
R316	Same as R315		R342	Same as R341	
R317	Res., 120 $\pm$ 5 %, 1/4 W, metal	74 230 113 0	R343	Res., 100 $\pm$ 2 %, 2 W, carbon	74 243 017 0
R318	Same as R317		R344	Same as R343	
R319	Res., B100 var., 0.1 W, metal	74 349 083 0	R345	Res., 47 $\pm$ 2 %, 1/2 W, carbon	74 241 012 0
R320	Same as R310		R346	Res., B500 var., 0.1 W, metal	74 349 076 0
R321	Same as R310		R347	Res., 43 $\pm$ 2 %, 1 W, carbon	74 242 113 0

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R348	Same as R347	
R350	Same as R326	
R351	Res., 27 k $\pm$ 5 %, 1/4 W, metal	74 230 039 0
R352	Res., 47 k $\pm$ 5 %, 1/4 W, metal	74 230 017 0
R353	Same as R352	
R354	Res., 150 $\pm$ 5 %, 1/4 W, metal	74 230 051 0
R355	Same as R302	
R356	Same as R319	

TRANSISTORS

TR301	Transistor 2N3571	74 030 475 0
TR302	Same as TR301	
TR303	Same as TR301	
TR304	Same as TR301	
TR305	Transistor 2SC857K	74 030 428 0
TR306	Same as TR305	
TR307	Transistor BFW30	74 030 462 0
TR308	Same as TR307	
TR309	Transistor 2N5109	74 030 461 0
TR310	Same as TR309	

NEON LAMP

NE301	Neon Lamp NE-2	74 020 111 0
NE302	Neon Lamp NE-2	
	Socket of Neon Lamp Type C	74 480 149 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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CONNECTORS

J301	Connector 143-012-01 Type 143	74 500 358 0
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CABLE

W301	Delay Cable CD-5 (L = 2.5 m)	52 850 500 9
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TRANSFORMER

T301	Toroidal Transformer	74 400 285 0
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HEAT DISSIPATOR

	Semiconductor Heat Dissipator	74 030 258 0
	TXBF-019-025	
	Heat Dissipator (Beryllia) 1G-45024	74 030 364 0

SOCKET

	Socket of Vacuum Tube	74 480 028 0
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A TRIGGER GENERATOR

CAPACITORS

C400	Cap., 2 pF $\pm$ 0.5 pF, 50 WVDC, cer.	74 050 169 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C401	Cap., 3 pF ± 0.5 pF, 50 WVDC, cer.	74 050 545 0
C402	Cap., 47 pF ± 10 %, 50 WVDC, cer.	74 050 203 0
C403	Cap., 0.047 μ F ± 20 %, 400 WVDC, poly.	74 130 331 0
C404	Same as C402	
C405	Cap., 0.1 μ F -20 — +80 %, 25 WVDC, cer.	74 060 233 0
C406	Same as C405	
C406b	Cap., 1 pF, 16 WVDC, elect. tan	74 120 282 0
C406c	Cap., 10 pF ± 1 %, 50 WVDC, cer.	74 050 192 0
C407	Cap., 20 pF ± 5 %, 50 WVDC, cer.	74 050 528 0
C408	Cap., 8 pF ± 1 pF, 50 WVDC, cer.	74 050 560 0
C409	Cap., 150 pF ± 10 %, 50 WVDC, cer.	74 050 301 0
C410	Cap., 0.01 μ F -20 — +80 %, 25 WVDC, cer.	74 060 056 0
C411	Cap., 0.001 μ F -20 — +80 %, 50 WVDC, cer.	74 060 055 0
C412	Same as C411	
C413	Same as C410	
C414	Same as C410	
C415	Same as C407	
C416	Same as C410	
C417	Same as C410	
C418	Same as C400	
C419	Same as C410	
C421	Same as C410	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C422	Cap., 0.05 μ F -20 — +80 %, 25 WVDC, cer.	74 060 122 0
C423	Same as C405	
C424	Cap., 200 pF ± 5 %, 50 WVDC, cer.	74 050 175 0
C425	Cap., 4 pF ± 0.5 pF, 50 WVDC, cer.	74 050 472 0
C426	Same as C405	
C427	Same as C424	
C428	Cap., 3.3 μ F ± 20 %, 16 WVDC, elect. tan	74 120 148 0
C429	Cap., 4.7 μ F ± 20 %, 35 WVDC, elect. tan	74 120 407 0
C429b	Same as C409	
C430	Same as C405	
C431	Same as C405	
C432	Same as C405	
C433	Same as C405	
C434	Same as C405	
C435	Cap., 22 μ F ± 20 %, 16 WVDC, elect. tan	74 120 486 0
C436	Same as C435	
C437	Same as C405	
C438	Cap., 220 pF ± 10 %, 50 WVDC, cer.	74 050 275 0

COILS

L400	Inductor [Peaking Coil (A) 5T]	74 400 383 0
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CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
L401	Inductor (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
L402	Same as L401	
L403	Same as L401	
L404	Same as L401	
L405	Inductor [Peaking Coil (B) 10T]	74 400 384 0
L406	Same as L401	

RESISTORS

R400	Res., $47 \pm 5\%$, 1/4 W, compo.	74 253 007 0
R401	Res., $910 \text{ k} \pm 5\%$, 1/4 W, compo.	74 253 138 0
R402	Res., $110 \text{ k} \pm 5\%$, 1/4 W, compo.	74 253 130 0
R403	Res., $100 \text{ k} \pm 5\%$, 1/4 W, compo.	74 253 129 0
R404	Same as R403	
R405	Same as R401	
R406	Res., $100 \text{ k} \pm 2\%$, 1 W, carbon	74 242 075 0
R407	Res., $27 \pm 5\%$, 1/4 W, compo.	74 253 075 0
R408	Res., B50 k, B10 k, var., [LEVEL, (PULL HF) STABILITY] 0.125 W, with push-pull switch carbon	74 325 255 0
R409	Res., $100 \pm 5\%$, 1/4 W, compo.	74 253 008 0
R410	Res., $4.7 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 029 0
R411	Res., B10 k, var., (Level Center), 0.5 W, W.W.	74 331 063 0
R412	Res., $9.1 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 109 0
R413	Same as R410	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R414	Res., $680 \pm 5\%$, 1/4 W, metal	74 230 015 0
R415	Res., $24 \pm 5\%$, 1/4 W, metal	74 230 160 0
R416	Res., $1 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 003 0
R417	Res., $10 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 012 0
R418	Res., $27 \pm 5\%$, 1/4 W, metal	74 230 138 0
R419	Res., $270 \pm 5\%$, 1/4 W, metal	74 230 091 0
R421	Res., $75 \pm 5\%$, 1/4 W, metal	74 230 088 0
R422	Res., $91 \pm 5\%$, 1/4 W, metal	74 230 123 0
R423	Same as R416	
R424	Same as R416	
R425	Res., $130 \pm 5\%$, 1/4 W, metal	74 230 115 0
R426	Same as R425	
R427	Res., $15 \pm 5\%$, 1/4 W, compo.	74 253 141 0
R428	Res., $10 \pm 5\%$, 1/4 W, metal	74 230 007 0
R430	Same as R410	
R431	Res., $100 \pm 5\%$, 1/4 W, metal	74 230 013 0
R432	Res., $110 \pm 5\%$, 1/4 W, metal	74 230 152 0
R433	Same as R432	
R434	Same as R431	
R435	Res., $3.6 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 108 0
R436	Same as R435	
R437	Same as R407	
R438	Same as R407	
R441	Res., $3 \text{ k} \pm 5\%$, 1/4 W, metal	74 230 053 0
R442	Same as R441	
R445	Same as R407	
R446	Same as R407	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R447	Same as R427		R476	Res., B500 var., (Trig Stability), 0.5 W, W.W.	74 331 070 0
R448	Same as R427		R476b	Res., 1.5 k $\pm$ 2 %, 1/2 W, carbon	74 241 046 0
R450	Same as R419		R477	Res., 750 $\pm$ 5 %, 1/4 W, metal	74 230 054 0
R451	Same as R418		R478	Res., 20 $\pm$ 5 %, 1/4 W, metal	74 230 114 0
R452	Same as R407		R479	Same as R400	
R453	Res., 33 $\pm$ 5 %, 1/4 W, metal	74 230 028 0	R480	Res., 2.4 k $\pm$ 5 %, 1/4 W, metal	74 230 022 0
R454	Same as R418		R481	Res., 47 $\pm$ 5 %, 1/4 W, metal	74 230 010 0
R455	Same as R414		R482	Res., 330 $\pm$ 5 %, 1/4 W, metal	74 230 047 0
R456	Same as R414		R483	Res., 12 k $\pm$ 5 %, 1/4 W, metal	74 230 144 0
R457	Res., 2.7 k $\pm$ 5 %, 1/4 W, metal	74 230 042 0	R484	Res., 7.5 k $\pm$ 5 %, 1/4 W, metal	74 230 057 0
R458	Res., 56 $\pm$ 5 %, 1/4 W, metal	74 230 094 0	R485	Same as R481	
R460	Same as R428		R486	Same as R483	
R461	Res., 1.8 k $\pm$ 5 %, 1/4 W, metal	74 230 081 0	R487	Same as R482	
R462	Same as R414		R488	Res., 100 k $\pm$ 5 %, 1/4 W, metal	74 230 026 0
R463	Same as R418		R489	Res., 43 $\pm$ 5 %, 1/4 W, metal	74 230 122 0
R464	Res., 910 $\pm$ 5 %, 1/4 W, metal	74 230 126 0	R490	Res., 4.3 k $\pm$ 5 %, 1/4 W, metal	74 230 131 0
R465	Same as R415		R491	Same as R490	
R467	Res., 820 $\pm$ 5 %, 1/4 W, metal	74 230 049 0	R492	Same as R410	
R468	Same as R427		R493	Res., 30 k $\pm$ 5 %, 1/4 W, metal	74 230 092 0
R469	Same as R419		R494	Same as R412	
R470	Same as R428		R495	Same as R419	
R471	Same as R418		R496	Same as R441	
R472	Same as R425		R497	Same as R483	
R473	Same as R464		R498	Res., 1.5 k $\pm$ 5 %, 1/4 W, metal	74 230 011 0
R474	Same as R427		R499	Same as R488	
R475	Res., 6.8 k $\pm$ 5 %, 1/4 W, metal	74 230 033 0			

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
DIODES		
D400	Diode 1S1458	74 040 292 0
D401	Same as D400	
D402	Same as D400	
D403	Same as D400	
D404	Same as D400	
D405	Same as D400	
D406	Same as D400	
D407	Same as D400	
D408	Same as D400	
D409	Z. Diode RD6A	74 040 079 0
D409b	Diode 1S953	74 040 172 0
D411	T. Diode 1S1762	74 040 253 0
D412	Diode 1S1992	74 040 393 0
D413	Same as D413	
D414	Same as D411	
D415	Same as D409	
D416	Same as D400	
D418	Same as D400	
D422	Same as D400	
D423	Same as D400	
D424	Same as D400	
D425	Same as D400	
D426	Same as D400	
D427	Same as D400	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TRANSISTORS		
TR400	FET 2N4416	74 030 459 0
TR401	Transistor 2N4260	74 030 360 0
TR402	Transistor 2N5179	74 030 431 0
TR403	Transistor 2SC989	74 030 497 0
TR411	Same as TR401	
TR412	Same as TR402	
TR413	Same as TR403	
TR434	Transistor 2N4957	74 030 460 0
TR435	Same as TR434	
TR436	Same as TR402	
TR437	Same as TR402	
TR447	Transistor 2N4275	74 030 316 0
TR448	Same as TR447	
TR457	Same as TR447	
TR458	Transistor 2N4121	74 030 299 0
TR459	Same as TR447	
SWITCHES		
S400	Lever Switch LS-P-1-5-4 (SOURCE)	74 440 185 0
S401	Lever Switch LS-P-1-1-4 (COUPLING)	74 440 172 0
S402	Lever Switch SL-P-1-2-2 (SLOPE)	74 440 052 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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CONNECTOR

J400	Connector TYPE BNC UG625/U-Ni (EXT TRIG)	74 500 253 0
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TRANSFORMERS

T401	Pulse Transformer (A) 4T-2T	74 400 475 0
T402	Pulse Transformer (B) 4T-3T	74 400 476 0

A SWEEP GENERATOR

CAPACITORS

C501	Cap., 33 pF, 25 WVDC, elect. tan	74 120 395 0
C503	Cap., 82 pF $\pm 10\%$, 50 WVDC, cer.	74 050 473 0
C503b	Cap., 220 pF $\pm 10\%$, 50 WVDC, cer.	74 050 275 0
C503c	Cap., 0.01 μ F -20 - +80 %, 50 WVDC, cer.	74 060 056 0
C503d	Same as C503c	
C504	Cap., 47 pF $\pm 10\%$, 50 WVDC, cer.	74 050 273 0
C504b	Cap., 0.01 μ F -20 - +80 %, 25 WVDC, cer.	74 060 056 0
C505	Same as C504	
C506	Cap., 39 pF $\pm 10\%$, 50 WVDC, cer.	74 050 338 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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C507	Cap., 10 pF ± 1 pF, 50 WVDC, cer.	74 050 170 0
C508	Cap., 330 pF $\pm 5\%$, 50 WVDC, cer.	74 050 304 0
C509	Cap., 0.001 μ F -20 - +80 %, 50 WVDC, cer.	74 060 055 0
C510	Cap., 68 pF $\pm 10\%$, 50 WVDC, cer.	74 050 339 0
C510b	Cap., 10 μ F, 10 WVDC, elect. tan	
C513	Cap., 0.1 μ F -20 - +80 %, 25 WVDC, cer.	74 060 233 0

COILS

L500	Inductor, (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
L599	Same as L500	

RESISTORS

R501	Res., 1 k $\pm 5\%$, 1/4 W, metal	74 230 003 0
R502	Res., B1 k var., (TD Bias), 0.5 W, W.W.	74 331 058 0
R503	Res., 4.7 $\pm 5\%$, 1/4 W, metal	74 230 029 0
R524	Res., 620 $\pm 5\%$, 1/4 W, metal	74 230 104 0
R505	Res., 24 $\pm 5\%$, 1/4 W, metal	74 230 160 0
R507	Res., 750 $\pm 0.5\%$, 1/8 W, metal	74 221 102 0
R508	Res., 620 $\pm 0.5\%$, 1/8 W, metal	74 221 101 0
R510	Res., 33 $\pm 5\%$, 1/4 W, metal	74 230 028 0
R511	Res., 12 k $\pm 5\%$, 1/4 W, metal	74 230 044 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R512	Res., 3.3 k ± 0.5 %, 1/8 W, metal	74 221 103 0
R513	Res., 18.7 k ± 0.5 %, 1/2 W, metal	74 221 104 0
R514	Res., 43 ± 5 %, 1/4 W, metal	74 230 122 0
R515	Res., 360 ± 5 %, 1/4 W, metal	74 230 111 0
R516	Res., 10 k ± 5 %, 1/4 W, metal	74 230 012 0
R517	Res., 47 ± 5 %, 1/4 W, metal	74 230 010 0
R517b	Res., 10 ± 10 %, 1/4 W, compo.	74 253 125 0
R519	Same as R517	
R520	Same as R511	
R521	Same as R501	
R522	Res., 2.4 k ± 5 %, 1/4 W, metal	74 230 022 0
R523	Same as R501	
R524	Same as R511	
R525	Res., 56 ± 5 %, 1/4 W, metal	74 230 094 0
R526	Res., 100 ± 5 %, 1/4 W, metal	74 230 013 0
R527	Same as R503	
R528	Same as R517	
R529	Res., 7.5 k ± 2 %, 2 W, carbon	74 243 054 0
R530	Res., 6.2 k ± 5 %, 1/4 W, metal	74 230 089 0
R531	Res., 240 ± 5 %, 1/4 W, metal	74 230 125 0
R532	Res., 330 ± 5 %, 1/4 W, metal	74 230 047 0
R533	Res., 200 ± 5 %, 1/4 W, metal	74 230 134 0
R534	Same as R526	
R535	Res., 27 ± 5 %, 1/4 W, metal	74 230 138 0
R536	Res., 6.2 k ± 2 %, 1 W, carbon	74 242 047 0
R537	Res., 5.6 k ± 2 %, 2 W, carbon	74 243 001 0
R539	Same as R525	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R540	Same as R526	
R541	Res., 3 M ± 5 %, 1/4 W, compo.	74 253 033 0
R542	Same as R526	
R543	Res., 620 ± 2 %, 1/2 W, carbon	74 241 039 0
R544	Res., 560 ± 5 %, 1/4 W, metal	74 230 058 0
R545	Same as R502 (Stop)	
R546	Same as R531	
R547	Same as R516	
R548	Res., B2 k var., (Stability), 0.3 W, metal	74 349 093 0
R549	Res., 430 ± 5 %, 1/4 W, metal	74 230 130 0
R550	Same as R522	
R552	Same as R510	
R553	Same as R503	
R554	Same as R503	
R556	Res., 43 k ± 5 %, 1/4 W, metal	74 230 140 0
R557	Res., 22 k ± 5 %, 1/4 W, metal	74 230 032 0
R558	Res., 51 k ± 5 %, 1/4 W, compo.	74 253 161 0
R559	Same as R532	
R560	Res., 2.2 k ± 5 %, 1/4 W, metal	74 230 027 0
R561	Res., 1.5 k ± 5 %, 1/4 W, metal	74 230 011 0
R562	Same as R549	
R563	Same as R517	
R564	Res., 820 ± 5 %, 1/4 W, metal	74 230 049 0
R565	Same as R517	
R580	Res., 5.6 k ± 5 %, 1/4 W, metal	74 230 052 0
R581	Res., 13 ± 5 %, 1/4 W, metal	74 230 174 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R582	Same as R503	
R583	Same as R501	
R584	Same as R505	
R585	Res., 1.8 k $\pm$ 5 %, 1/4 W, metal	74 230 081 0
R586	Res., 33 k $\pm$ 5 %, 1/4 W, metal	74 230 030 0
R587	Same as R532	
R588	Same as R517	
R589	Res., 750 $\pm$ 5 %, 1/4 W, metal	74 230 054 0
R590	Same as R526	
R591	Same as R532	
R592	Res., 75 $\pm$ 5 %, 1/4 W, metal	74 230 088 0
R592b	Res., 100 $\pm$ 5 %, 1/4 W, compo.	74 253 008 0
R593a	Res., 29 $\pm$ 5 %, 1/4 W, metal	74 230 103 0
R593b	Same as R526	
R594a	Res., 62 $\pm$ 5 %, 1/4 W, metal	74 230 105 0
R594b	Res., 1.2 k $\pm$ 5 %, 1/4 W, metal	74 230 050 0
R595	Res., 68 $\pm$ 5 %, 1/4 W, metal	74 230 105 0
R596	Same as R531	
R597	Same as R531	
R598	Same as R586	
R599a	Same as R580	
R599b	Res., B5 k var., (FET Bias) 0.5 W, W.W.	74 331 061 0
DIODES		
D501	T. Diode 1S1760	74 040 290 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D502	Diode 1S467	74 040 414 0
D503	Diode 1S953	74 040 172 0
D504	Z. Diode RD6A	74 040 079 0
D507	Same as D504	
D508	Same as D503	
D509	Same as D503	
D512	Same as D504	
D513	Diode 1S1458	74 040 292 0
D515	Same as D503	
D516	Same as D503	
D517	Same as D503	
D518	Same as D503	
D519	Z. Diode RD5A	74 040 077 0
D520	Same as D504	
D522	Same as D503	
D524	Same as D503	
D525	Same as D503	
D527	Same as D503	
D528	Same as D503	
D529	Same as D503	
D530	Same as D501	
D531	Same as D502	
D532	Same as D503	
D533	Same as D503	
D534	Same as D503	
D535	Same as D503	
D537	Same as D504	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D545	Same as D503	
D546	Same as D503	
D547	Same as D503	
D550	Same as D503	
D550b	Same as D503	

TRANSISTORS

TR501	Transistor 2N4275	74 030 316 0
TR502	Same as TR501	
TR503	Transistor 2N4121	74 030 299 0
TR504	Same as TR503	
TR505	Same as TR503	
TR506	FET 2SK12-(Y)	74 030 292 0
TR507	Transistor TA2761/4068	74 030 317 0
TR508	Transistor 2SA539	74 030 141 0
TR509	Same as TR503	
TR510	FET 2N5462 (MPF153)	74 030 532 0
TR511	Same as TR501	
TR512	Transistor 2SC857K	74 030 428 0
TR513	Same as TR503	
TR514	Same as TR503	
TR515	Same as TR503	
TR520	Same as TR503	
TR525	Same as TR501	
TR526	Same as TR503	
TR530	Same as TR503	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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TR535 Same as TR501

NEON LAMP

NE501 Neon Lamp NL-2S (READY) 74 020 178 0

SWITCH

S501 Lever Switch LSP1-2-3 (MODE) 74 440 170 0

CONNECTOR

J501 Connector CR6-36S-3-96E 74 500 356 0

B TRIGGER GENERATOR

CAPACITORS

C700	Cap., 2 pF ± 0.5 pF, 50 WVDC, cer.	74 050 169 0
C701	Cap., 3 pF ± 0.5 pF, 50 WVDC, cer.	74 050 545 0
C702	Cap., 470 pF ± 10 %, 50 WVDC, cer.	74 050 208 0
C703	Cap., 0.047 μ F ± 20 %, 400 WVDC, poly.	74 130 382 0
C704	Same as C702	
C705	Cap., 0.1 μ F -20 — +80 %, 25 WVDC, cer.	74 060 233 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C706	Same as C705	
C706b	Cap., 10 pF ± 1 pF, 50 WVDC, cer.	74 050 192 0
C707	Cap., 20 pF ± 5 %, 50 WVDC, cer.	74 050 528 0
C708	Cap., 8 pF ± 1 pF, 50 WVDC, cer.	74 050 560 0
C709	Same as C705	
C710	Same as C705	
C711	Cap., 0.001 μ F -20 - +80 %, 50 WVDC, cer.	74 060 055 0
C712	Same as C711	
C713	Cap., 47 pF ± 10 %, 50 WVDC, cer.	74 050 273 0
C714A	Cap., 0.01 μ F -20 - +80 %, 25 WVDC, cer.	74 060 056 0
C714B	Same as C714A	
C715	Same as C707	
C716	Same as C714A	
C717	Same as C714A	
C718	Same as C714A	
C719	Same as C700	
C720	Cap., 150 pF ± 10 %, 50 WVDC, cer.	74 050 301 0
C721	Same as C714A	
C722	Cap., 0.05 μ F -20 - +80 %, 25 WVDC, cer.	74 060 122 0
C723	Same as C705	
C724	Cap., 200 pF ± 5 %, 50 WVDC, cer.	74 050 175 0
C725	Cap., 4 pF ± 0.5 pF, 50 WVDC, cer.	74 050 472 0
C738	Same as C724	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C773	Cap., 4.7 μ F ± 20 %, 16 WVDC, elect. tan	74 120 147 0
C773b	Same as C720	
C773c	Cap., 220 pF ± 10 %, 50 WVDC, cer.	74 050 275 0
C774	Same as C714A	
C775	Same as C714A	
C776	Cap., 33 μ F ± 20 %, 16 WVDC, elect. tan	74 120 406 0
C777	Same as C776	
C778A	Same as C714A	
C778B	Same as C714A	

COILS

L700	Inductor, [Peaking Coil (A)] 5T	74 400 383 0
L701	Inductor, (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
L702	Same as L701	
L703	Same as L701	
L704	Same as L701	
L705	Inductor, [Peaking Coil (B)] 10T	74 400 384 0
L706	Same as L701	

RESISTORS

R700	Res., 47 ± 5 %, 1/4 W, compo.	74 253 007 0
R701	Res., 910 k ± 5 %, 1/4 W, compo.	74 253 138 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R702	Res., 110 k $\pm$ 5 %, 1/4 W, compo.	74 253 130 0
R703	Res., 100 k $\pm$ 5 %, 1/4 W, compo.	74 253 129 0
R704	Same as R703	
R705	Same as R701	
R706	Res., 100 k $\pm$ 2 %, 1 W, carbon	74 242 075 0
R707	Res., 27 $\pm$ 5 %, 1/4 W, compo.	74 253 005 0
R708	Res., B50 k var., (LEVEL), 0.125 W, with push-pull switch carbon	74 323 052 0
R709	Res., 100 $\pm$ 5 %, 1/4 W, compo.	74 253 008 0
R710	Res., 47 k $\pm$ 5 %, 1/4 W, metal	74 230 029 0
R711	Res., B10 k var., (Level Center), 0.5 W, W.W.	74 331 060 0
R712	Res., 9.1 k $\pm$ 5 %, 1/4 W, metal	74 230 109 0
R713	Same as R710	
R714	Res., 680 $\pm$ 5 %, 1/4 W, metal	74 230 015 0
R715	Res., 24 $\pm$ 5 %, 1/4 W, metal	74 230 160 0
R716	Res., 1 k $\pm$ 5 %, 1/4 W, metal	74 230 003 0
R717	Res., 3 k $\pm$ 5 %, 1/4 W, metal	74 230 053 0
R718	Res., 27 $\pm$ 5 %, 1/4 W, metal	74 230 138 0
R719	Res., 15 $\pm$ 5 %, 1/4 W, metal	74 230 117 0
R720	Same as R719	
R721	Res., 75 $\pm$ 5 %, 1/4 W, metal	74 230 088 0
R722	Res., 91 $\pm$ 5 %, 1/4 W, metal	74 230 123 0
R723	Same as R716	
R724	Same as R716	
R725	Res., 130 $\pm$ 5 %, 1/4 W, metal	74 230 115 0
R726	Same as R725	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R727	Res., 115 $\pm$ 5 %, 1/4 W, compo.	74 253 141 0
R728	Same as R727	
R729	Same as R727	
R730	Res., 10 k $\pm$ 5 %, 1/4 W, metal	74 230 012 0
R731	Same as R709	
R732	Res., 110 $\pm$ 5 %, 1/4 W, compo.	74 253 086 0
R733	Same as R732	
R734	Same as R707	
R735	Res., 3.6 k $\pm$ 5 %, 1/4 W, metal	74 230 108 0
R736	Same as R735	
R737	Same as R707	
R738	Same as R707	
R741	Same as R717	
R742	Same as R717	
R745	Same as R707	
R746	Same as R707	
R750A	Res., 270 $\pm$ 5 %, 1/4 W, compo.	74 253 093 0
R750B	Res., 270 $\pm$ 5 %, 1/4 W, metal	74 230 091 0
R751	Same as R718	
R752	Same as R707	
R753	Res., 33 $\pm$ 5 %, 1/4 W, metal	74 230 028 0
R754	Same as R718	
R755	Same as R714	
R756	Same as R714	
R757	Res., 2.7 k $\pm$ 5 %, 1/4 W, metal	74 230 042 0
R758	Res., 56 $\pm$ 5 %, 1/4 W, metal	74 230 094 0
R761	Res., 1.8 k $\pm$ 5 %, 1/4 W, metal	74 230 081 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R762	Same as R714		DIODES		
R763	Same as R718				
R764	Res., $910 \pm 5 \%$, 1/4 W, metal	74 230 126 0	D700	Diode 1S1458	74 040 292 0
R765	Res., $24 \pm 5 \%$, 1/4 W, compo.	74 253 154 0	D700b	Diode 1S953	74 040 172 0
R767	Res., $820 \pm 5 \%$, 1/4 W, metal	74 230 049 0	D701	Same as D700	
R768	Same as R719		D702	Same as D700	
R770	Same as R718		D703	Same as D700	
R771	Same as R718		D704	Same as D700	
R772	Same as R725		D705	Same as D700	
R773	Same as R764		D706	Same as D700	
R774	Same as R750B		D707	Same as D700	
R775	Res., $68 \text{ k} \pm 5 \%$, 1/4 W, metal	74 230 033 0	D708	Same as D700	
R776	Res., B500 var., (Trig Stability), 0.5 W, W.W.	74 331 070 0	D709	Z. Diode RD6A	74 040 079 0
R777	Res., $750 \pm 5 \%$, 1/4 W, metal	74 230 054 0	D711	T. Diode 1S1762	74 040 253 0
R778	Res., $20 \pm 5 \%$, 1/4 W, metal	74 230 114 0	D712	Diode 1S1659/1S1992	74 040 390 0
R779	Res., $47 \pm 5 \%$, 1/4 W, metal	74 230 010 0	D713	Same as D712	
R780	Res., $2.4 \text{ k} \pm 5 \%$, 1/4 W, metal	74 230 022 0	D714	Same as D711	
R781	Same as R700		D715	Same as D709	
R782	Res., $330 \pm 5 \%$, 1/4 W, metal	74 230 047 0	D716	Same as D700	
R783	Res., $12 \text{ k} \pm 5 \%$, 1/4 W, metal	74 230 044 0	D718	Same as D700	
R784	Res., $5.6 \text{ k} \pm 5 \%$, 1/4 W, metal	74 230 052 0	TRANSISTORS		
R785	Same as R719				
R786	Res., $10 \pm 5 \%$, 1/4 W, metal	74 220 007 0	TR700	FET 2N4416	74 030 459 0
R787	Same as R786		TR701	Transistor 2N4260	74 030 360 0
R788A	Same as R719		TR702	Transistor 2N5179	74 030 431 0
R788B	Same as R719		TR703	Transistor 2SC989	74 030 497 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TR711	Same as D701	
TR712	Same as TR702	
TR713	Same as TR703	
TR734	Transistor 2N4957	74 030 460 0
TR735	Same as TR734	
TR736	Same as TR702	
TR737	Same as TR702	

SWITCHES

S700	Lever Switch LS-P-1-5-4 (SOURCE)	74 440 185 0
S701	Lever Switch LS-P-1-1-4 (COUPLING)	74 440 172 0
S702	Lever Switch SL-P-1-2-2 (SLOPE)	74 440 052 0

CONNECTOR

J700	Connector TYPE BNC UG625/U-Ni (EXT TRIG)	74 500 253 0
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TRANSFORMERS

T701	Pulse Transe (A) 4T-5T	74 400 475 0
T707	Ferrite Core TYPE OR	74 560 104 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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RELAY

RL700	Relay TO-5 712-12	74 450 106 0
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B SWEEP GENERATOR

CAPACITORS

C802	Cap., 0.1 μ F -20 - +80 %, 25 WVDC, cer.	74 060 233 0
C803	Cap., 82 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 473 0
C803b	Cap., 220 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 275 0
C803c	Cap., 0.01 μ F -20 - +80 %, 50 WVDC, cer.	74 060 056 0
C803d	Same as C803c	
C804	Cap., 47 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 273 0
C805	Same as C804	
C806	Cap., 39 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 338 0
C806b	Same as C803c	
C807	Cap., 10 pF $\pm$ 1 pF, 50 WVDC, cer.	74 050 170 0
C808	Cap., 330 pF $\pm$ 5 %, 50 WVDC, cer.	74 050 304 0
C809	Cap., 0.001 μ F -20 - +80 %, 50 WVDC, cer.	74 060 055 0
C810	Cap., 20pF $\pm$ 5 %, 50 WVDC, cer.	74 050 528 0
C813	Same as C802	
C816	Same as C809	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C819	Same as C808	
C841	Same as C802	
C841b	Cap., 100 μ F -10 — +100 %, 25 WVDC, elect.	74 120 088 0
C843	Same as C802	
COILS		
L599	Inductor, (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
L800	Same as L599	
RESISTORS		
R801	Res., 1 k $\pm$ 5 %, 1/4 W, metal	74 230 003 0
R802	Res., B1 k var., (T.D. Bias) 0.5 W, W.W.	74 331 058 0
R803	Res., 4.7 k $\pm$ 5 %, 1/4 W, metal	74 230 029 0
R804	Res., 620 $\pm$ 5 %, 1/4 W, metal	74 230 104 0
R806	Res., 100 $\pm$ 5 %, 1/4 W, metal	74 230 013 0
R807	Res., 24 $\pm$ 5 %, 1/4 W, metal	74 230 160 0
R808	Res., 330 $\pm$ 5 %, 1/4 W, metal	74 230 047 0
R809	Res., 750 $\pm$ 0.5 %, 1/8 W, metal	74 221 102 0
R810	Res., 33 $\pm$ 5 %, 1/4 W, metal	74 230 028 0
R811	Res., 12 k $\pm$ 5 %, 1/4 W, metal	74 230 044 0
R812	Res., 3.3 k $\pm$ 0.5 %, 1/8 W, metal	74 221 103 0
R813	Res., 18.7 k $\pm$ 0.5 %, 1/2 W, metal	74 221 104 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R814	Res., 43 $\pm$ 5 %, 1/4 W, metal	74 230 122 0
R815	Res., 360 $\pm$ 5 %, 1/4 W, metal	74 230 111 0
R816	Res., 10 k $\pm$ 5 %, 1/4 W, metal	74 230 012 0
R817	Res., 47 $\pm$ 5 %, 1/4 W, metal	74 230 010 0
R818	Res., 30 k $\pm$ 5 %, 1/4 W, metal	74 230 092 0
R819	Same as R817	
R820	Res., 12 k $\pm$ 5 %, 1/4 W, metal	74 230 044 0
R821	Res., 1 k $\pm$ 5 %, 1/4 W, metal	74 230 003 0
R822	Res., 2.4 k $\pm$ 5 %, 1/4 W, metal	74 230 022 0
R823	Same as R821	
R824	Same as R820	
R825	Res., 56 $\pm$ 5 %, 1/4 W, metal	74 230 094 0
R826	Same as R806	
R828	Same as R817	
R828b	Same as R806	
R829	Res., 7.5 k $\pm$ 2 %, 2 W, carbon	74 243 054 0
R829b	Same as R818	
R830	Res., 6.2 k $\pm$ 5 %, 1/4 W, metal	74 230 089 0
R831	Res., 240 $\pm$ 5 %, 1/4 W, metal	74 230 125 0
R832	Same as R808	
R833	Res., 200 $\pm$ 5 %, 1/4 W, metal	74 230 134 0
R834	Same as R806	
R835	Res., 27 $\pm$ 5 %, 1/4 W, metal	74 230 138 0
R836	Res., 6.2 k $\pm$ 2 %, 1 W, carbon	74 242 047 0
R837	Res., 5.6 k $\pm$ 2 %, 2 W, carbon	74 243 051 0
R838	Same as R806	
R839	Same as R825	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R840	Res., 18 k $\pm 2\%$, 1/2 W, carbon	74 241 071 0	R872b	Res., 68 $\pm 2\%$, 1/2 W, carbon	74 241 016 0
R841	Res., 39 k $\pm 5\%$, 1/4 W, metal	74 230 078 0	R873	Res., 8.2 k $\pm 2\%$, 1 W, carbon	74 242 050 0
R843	Res., 560 $\pm 2\%$, 1/2 W, carbon	74 241 038 0	R874	Res., 39 $\pm 5\%$, 1/4 W, metal	74 230 103 0
R844	Res., 1.1 k $\pm 5\%$, 1/4 W, metal	74 230 153 0	R875	Same as R817	
R844b	Res., 510 $\pm 5\%$, 1/4 W, metal	74 230 045 0	R876	Same as R803	
R847A	Same as R816		R876b	Same as R822	
R847B	Same as R810		R877	Same as R818	
R849	Res., 430 $\pm 5\%$, 1/4 W, metal	74 230 130 0	R878	Res., B2 k, Var., (Start Adj) 0.5 W, W.W.	74 331 062 0
R851	Same as R808		R878b	Res., 8.2 k $\pm 5\%$, 1/4 W, metal	74 230 043 0
R852A	Res., 2 k $\pm 5\%$, 1/4 W, metal	74 230 041 0	R879	Res., 2 k $\pm 3\%$, var., (DELAY TIME MULTI), 2 W, W.W.	74 341 038 0
R852B	Same as R810		R880	Same as R878 (Stop Adj)	
R853	Same as R844b		R880b	Same as R878b	
R854	Same as R803		R881	Same as R865	
R854b	Same as R817		R882	Res., 3.6 k $\pm 5\%$, 1/4 W, metal	74 230 108 0
R855A	Same as R831		R883	Same as R806	
R855B	Same as R831		R884	Res., 910 $\pm 2\%$, 1/2 W, carbon	74 241 043 0
R856	Same as R831		R885	Res., 1.8 k $\pm 5\%$, 1/4 W, metal	74 230 081 0
R857	Same as R852A		R888	Same as R817	
R860	Res., 2.2 k $\pm 5\%$, 1/4 W, metal	74 230 027 0	R889	Same as R861	
R861	Res., 1.5 k $\pm 5\%$, 1/4 W, metal	74 230 011 0	R890	Same as R806	
R862	Same as R849		R892	Same as R806	
R863	Same as R817		R893	Same as R817	
R864	Res., 750 $\pm 5\%$, 1/4 W, metal	74 230 054 0	R894	Same as R822	
R865	Res., 51 $\pm 5\%$, 1/4 W, metal	74 230 060 0	R895	Res., 36 k $\pm 5\%$, 1/4 W, metal	74 230 090 0
R867	Same as R864		R896	Same as R874	
R868	Same as R808				
R872	Same as R806				

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R897	Res., 75 $\pm$ 5 %, 1/4 W, metal	74 230 088 0
R898	Res., 620 $\pm$ 0.5 %, 1/8 W, metal	74 231 101 0
R899a	Res., B10 k var., (FET Bias)	74 331 063 0
	0.5 W, W.W.	
R899b	Same as R810	

DIODES

D801	T. Diode 1S1760	74 040 290 0
D802	Diode 1S467	74 040 414 0
D803	Diode 1S953	74 040 172 0
D804	Z. Diode RD6A	74 040 079 0
D808	Same as D803	
D809	Same as D803	
D812	Same as D804	
D813	Same as D803	
D815	Same as D803	
D816	Same as D803	
D817	Same as D803	
D818	Same as D803	
D819	Z. Diode RD5A	74 040 077 0
D819b	Same as D803	
D820	Same as D804	
D821	Same as D803	
D822	Same as D803	
D823	Same as D804	
D824	Same as D803	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D826	Same as D803	
D827	Same as D803	
D830	T. Diode 1S1763	74 040 252 0
D831	Same as D802	
D833	Same as D803	
D834	Same as D803	
D837	Same as D804	
D841	Same as D803	
D855	Same as D801	
D856	Same as D801	
D860	Same as D819	
D700b	Same as D803	

TRANSISTORS

TR801	Transistor 2N4275	74 030 316 0
TR802	Same as TR801	
TR803	Transistor 2N4121	74 030 299 0
TR804	Same as TR803	
TR805	Same as TR803	
TR806	FET 2SK12- $\bar{Y}$	74 030 405 0
TR807	Transistor TA2761 (40608)	74 030 317 0
TR808	Transistor 2SA539	74 030 141 0
TR809	Same as TR803	
TR810	Same as TR803	
TR811	Same as TR801	
TR812	Same as TR801	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TR813	Same as TR803	
TR814	Same as TR803	
TR815	Same as TR803	
TR8181	Transistor (Twin) MD3250	74 030 507 0
TR819	Same as TR801	
TR820	Same as TR803	
TR822	Same as TR803	
TR830	Same as TR803	

CONNECTOR

J801	Connector CR6-36S-3-96E	74 500 356 0
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A · B TIMING

CAPACITORS (A)

C601	Cap., 10 pF ± 0.5 pF, 50 WVDC, cer.	74 050 170 0
C602	Cap., 100 pF ± 10 %, 50 WVDC, cer.	74 050 171 0
C603	Cap., 0.001 μ F -20 — +80 %, 25 WVDC, cer.	74 060 055 0
C604	Same as C603	
C605	Cap., 0.1 μ F -20 — +80 %, 25 WVDC, cer.	74 060 233 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C606	Cap., 1 μ F ± 20 %, 1.6 WVDC, elect. tan	74 120 185 0
C607	Cap., 3 pF — 20 pF var., 500 WVDC, cer.	74 110 010 0
C608	Cap., 33 pF ± 10 %, 50 WVDC, mica	74 090 421 0
C612	Same as C607	
C613	Same as C608	
C614	Same as C607	
C615	Same as C608	
C616	Cap., 950 pF -3 — +0 %, 300 WVDC, mica	74 090 468 0
C616b	Cap., 22 pF ± 10 %, 50 WVDC, mica (For adjustment)	74 090 520 0
C617	Cap., 0.01 μ F ± 1 %, 50 WVDC, poly.	74 130 176 0
C618	Cap., 0.1 μ F -2 — +0 %, 50 WVDC, poly.	74 130 219 0
C619	Cap., 1 μ F -2 — +0 %, 50 WVDC, poly.	74 130 227 0
C621	Cap., 100 μ F ± 20 %, 16 WVDC, elect. tan	74 120 170 0
C622	Cap., 0.01 μ F -20 — +80 %, 25 WVDC, cer.	74 060 056 0

CAPACITORS (B)

C907	Same as C607	
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C908	Same as C608		R616	Res., 66 k ± 0.5 %, 1/8 W, metal	74 221 160 0
C912	Same as C607		R617	Res., 171 k ± 0.5 %, 1/4 W, metal	74 221 121 0
C913	Same as C608		R618	Res., 346 k ± 0.5 %, 1/2 W, metal	74 221 117 0
C914	Same as C607		R619	Res., 696 k ± 0.5 %, 1/2 W, metal	74 221 118 0
C915	Same as C608		R620a	Res., 873 k ± 0.5 %, 1/2 W, metal	74 221 119 0
C916	Same as C616		R620b	Same as R620a	
C916b	Same as C616b		R621	Res., 35 M ± 1 %, 1/4 W, carbon	74 226 281 0
C917	Same as C617		R622	Res., 7 M ± 1 %, 1/4 W, carbon	74 226 282 0
C918	Same as C618		R623	Res., 10.5 M ± 1 %, 1/4 W, carbon	74 226 283 0
C919	Same as C619		R631	Res., B5 k var., 0.1 W, (A VARIABLE) with switch, carbon	74 332 066 0
C921	Same as C621		R631b	Res., 2.7 k ± 2 %, 1/4 W, carbon	74 241 052 0
RESISTORS (A)			R632	Res., 3.3 k ± 5 %, 1/4 W, metal	74 230 035 0
R601	Res., 5.6 k ± 2 %, 1/2 W, carbon	74 241 060 0	R633	Res., B5 k var., (A Sweep Adj) 0.5 W, W.W.	74 331 061 0
R602	Res., 12 k ± 2 %, 1/2 W, carbon	74 241 067 0	R634	Res., 300 ± 5 %, 1/4 W, metal	74 230 116 0
R603	Res., 36 k ± 2 %, 1/2 W, carbon	74 241 078 0	R635	Res., 9.1 k ± 5 %, 1/4 W, metal	74 230 109 0
R604	Res., 150 k ± 2 %, 1/2 W, carbon	74 241 093 0	R635b	Res., 18 k ± 5 %, 1/4 W, metal	74 230 046 0
R605	Res., 330 k ± 2 %, 1/2 W, carbon	74 241 101 0	R636	Res., 10 k ± 5 %, 1/4 W, metal	74 230 012 0
R606	Res., 510 k ± 2 %, 1/2 W, carbon	74 241 106 0	R636b	Res., 16 k ± 5 %, 1/4 W, metal	74 230 151 0
R607	Same as R606		R637	Res., 3.6 k ± 2 %, 2 W, carbon	74 243 046 0
R608	Res., 820 k ± 2 %, 1/2 W, carbon	74 241 111 0	R641	Same as R635b	
R611	Res., 4 k ± 0.5 %, 1/4 W, metal	74 221 120 0	R642	Same as R635b	
R612	Res., 3 k ± 0.5 %, 1/8 W, metal	74 221 156 0	R643	Res., 12 k ± 5 %, 1/4 W, metal	74 230 044 0
R613	Res., 11 k ± 0.5 %, 1/8 W, metal	74 221 157 0	R644	Res., 24 k ± 5 %, 1/4 W, metal	74 230 080 0
R614	Res., 35 k ± 0.5 %, 1/8 W, metal	74 221 159 0	R645	Res., 100 k ± 5 %, 1/4 W, metal	74 230 026 0
R615	Res., 31 k ± 0.5 %, 1/8 W, metal	74 221 158 0	R651	Res., 100 k ± 2 %, 1/2 W, carbon	74 241 089 0

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R654	Res., 3.9 k $\pm$ 2 %, 1/2 W, carbon	74 241 056 0
R687	Res., 91 $\pm$ 5 %, 1/4 W, metal	74 230 123 0

RESISTORS (B)

R901 (S902)	Res., B5 k var., 0.1 W, (B VARIABLE) with switch, carbon	74 322 233 0
R901b	Same as R631b	
R911	Same as R611	
R912	Same as R612	
R913	Same as R613	
R914	Same as R614	
R915	Same as R615	
R916	Same as R616	
R917	Same as R617	
R918	Same as R618	
R919	Same as R619	
R920a	Same as R620a	
R920b	Same as R620a	
R921	Same as R621	
R922	Same as R622	
R923	Same as R623	
R932	Same as R632	
R933	Same as R633 (B Sweep Adj)	
R934	Same as R634	
R935	Same as R635	
R935b	Same as R643	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R936	Same as R636	
R936b	Same as R636b	
R937	Same as R637	

DIODES (A)

D601	Diode 1S953	74 040 172 0
D602	Same as D601	
D603	Same as D601	
D604	Same as D601	
D605	Same as D601	

TRANSISTORS (A)

TR601	Transistor 2SD221	74 030 401 0
TR602	Transistor 2SC857K	74 030 428 0

TRANSISTOR (B)

TR901	Same as TR601	
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SWITCHES

S601a	Rotary Switch, S32P(24)6-11-24 (A TIME/DV)	74 431 626 0
S601b	Rotary Switch, 1S32P(24)4-6-24S ₁ / VR (B TIME/CM), with S601a	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
NEON LAMP		
NE601	Neon Lamp NE/2	74 020 111 0
	Socket of Neon Lamp Type C	74 480 149 0

 CONTROL CIRCUIT

CAPACITORS

C670	Cap., 0.01 μ F -20 — +80 %, 25 WVDC, cer.	74 060 056 0
C671	Cap., 0.001 μ F -20 — +80 %, 50 WVDC, cer.	74 060 175 0
C672	Cap., 47 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 273 0
C673	Cap., 0.1 μ F -20 — +80 %, 25 WVDC, cer.	74 060 233 0
C674	Same as C670	
C675	Cap., 300 pF $\pm$ 5 %, 50 WVDC, cer.	74 050 180 0
C676	Cap., 0.0022 μ F -20 — +80 %, 50 WVDC, cer.	74 060 084 0
C677	Same as C673	
C678	Same as C673	
C678b	Cap., 10 μ F -10 — +100 %, 16 WVDC, elect	74 120 311 0
C679	Cap., 2.2 μ F -15 — +75 %, 75 WVDC, elect. tan	74 120 283 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C680	Same as C676	
C683	Cap., 4.7 μ F $\pm$ 20 %, 10 WVDC, elect. tan	74 120 169 0

RESISTORS

R670	Res., 27 k $\pm$ 5 %, 1/4 W, metal	74 230 039 0
R670b	Res., 270 $\pm$ 2 %, 1/2 W, carbon	74 241 030 0
R671	Res., 2.7 k $\pm$ 5 %, 1/4 W, metal	74 230 042 0
R672	Res., 4.7 k $\pm$ 5 %, 1/4 W, metal	74 230 029 0
R673	Res., 1 k $\pm$ 5 %, 1/4 W, metal	74 230 003 0
R674	Same as R673	
R675	Res., 5.6 k $\pm$ 5 %, 1/4 W, metal	74 230 052 0
R676	Same as R675	
R677	Same as R675	
R678	Same as R675	
R679	Res., 75 k $\pm$ 5 %, 1/4 W, metal	74 230 059 0
R680	Res., 20 k $\pm$ 5 %, 1/4 W, metal	74 230 031 0
R681	Res., 56 k $\pm$ 5 %, 1/4 W, metal	74 230 056 0
R682	Same as R675	
R683	Same as R672	
R684	Res., 100 k $\pm$ 5 %, 1/4 W, metal	74 230 026 0
R685	Res., 15 $\pm$ 5 %, 1/4 W, metal	74 230 117 0
R686	Same as R685	
R687	Res., 91 $\pm$ 5 %, 1/4 W, metal	74 230 123 0
R689	Res., 910 $\pm$ 5 %, 1/4 W, metal	74 230 126 0
R690	Res., 43 $\pm$ 5 %, 1/4 W, metal	74 230 122 0

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R691	Res., 62 $\pm$ 5 %, 1/4 W, metal	74 230 124 0
R692	Same as R691	
R693	Res., 47 $\pm$ 5 %, 1/4 W, metal	74 230 010 0
R694	Res., 3.9 k $\pm$ 5 %, 1/4 W, metal	74 230 009 0
R695	Res., 12 k $\pm$ 5 %, 1/4 W, metal	74 230 044 0
R696	Same as R694	
R697	Same as R694	
R698	Res., 10 k $\pm$ 5 %, 1/4 W, metal	74 230 012 0
R699	Res., 51 k $\pm$ 5 %, 1/4 W, compo.	74 253 161 0

DIODES

D670	Diode 1S953	74 040 172 0
D671	Same as D670	
D672	Same as D670	
D673	Same as D670	
D674	Same as D670	
D675	Same as D670	
D676	Same as D670	
D677	Same as D670	
D678	Same as D670	
D680	Same as D670	
D681	Same as D670	

TRANSISTORS

TR670	Transistor 2N4275	74 030 316 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TR671	Transistor 2N4121	74 030 299 0
TR672	Same as TR672	
TR673	Same as TR672	
TR674	Same as TR672	
TR675	Transistor 2SC857K	74 030 428 0
TR676	Same as TR672	
TR677	Same as TR672	
TR678	Same as TR672	

SWITCH

S671	Push Switch MSP103C	74 430 009 0
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NEON LAMP

NE671	Neon Lamp NE-2 (B ENDS A)	74 020 111 0
	Socket of Neon Lamp Type C	74 480 149 0

HORIZONTAL AMPLIFIER

CAPACITORS

C1000	Cap., 6 – 20 pF var., 250 WVDC, cer.	74 110 063 0
C1001	Cap., 0.01 μ F -20 – +80 %, 25 WVDC, cer.	74 060 056 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1010	Same as C1000	
C1011	Same as C1001	
C1031	Cap., 0.1 μ F -20 - +80 %, 25 WVDC, cer.	74 060 033 0
C1050	Cap., 0.5 pF - 1.5 pF var., 500 WVDC, cer.	74 110 029 0
C1051	Cap., 1 pF $\pm$ 0.5 pF, 50 WVDC, cer.	74 050 077 0
C1060	Cap., 8.5 pF - 30 pF var., 250 WVDC, cer.	74 110 089 0
C1070	Same as C1031	
C1090	Cap., 3.3 μ F $\pm$ 20 %, 16 WVDC, elect. tan	74 120 148 0
C1091	Same as C1090	
C1092	Cap., 0.01 μ F -20 - +80 %, 150 WVDC, cer.	74 060 046 0
C1100	Same as C1060	
C1122	Same as C1031	
C1128	Same as C1050	
C1129	Same as C1051	
C1134	Same as C1092	
C1140	Cap., 15 μ F $\pm$ 20 %, 25 WVDC, elect. tan	74 120 198 0
C1145	Same as C1050	
C1146	Same as C1050	
C1152	Same as C1092	
C1153	Cap., 2.2 μ F -15 - +75 %, 150 WVDC, elect. tan	74 120 211 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1154	Same as C1051	
C1155	Same as C1050	
C1157	Same as C1031	
C1160	Cap., 27 pF $\pm$ 10 %, 50 WVDC, cer.	74 050 576 0
C1190	Cap., 10 μ F $\pm$ 20 %, 16 WVDC, elect. tan	74 120 186 0
C1191	Same as C1031	
C1092	Same as C1031	
C1193	Same as C1092	
C1194	Same as C1001	

COILS

L1000	Inductor, (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
L1123	Same as L1000	
L1123b	Same as L1000	
L1132	Same as L1000	
L1153	Same as L1000	

RESISTORS

R1000	Res., 6.2 k $\pm$ 5 %, 1/4 W, metal	74 230 089 0
R1001	Res., B10 k var., (A Position Center) 0.5 W, W.W.	74 331 063 0
R1002	Res., 20 k $\pm$ 5 %, 1/4 W, metal	74 230 031 0
R1003	Res., 1.5 k $\pm$ 5 %, 1/4 W, metal	74 230 011 0

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R1004	Res., 30 k $\pm$ 5 %, 1/4 W, metal	74 230 092 0
R1010	Same as R1000	
R1011	Same as R1001 (B Position Center)	
R1012	Same as R1002	
R1013	Same as R1003	
R1030	Res., 100 $\pm$ 5 %, 1/4 W, metal	74 230 013 0
R1030b	Res., 2 k $\pm$ 5 %, 1/4 W, metal	74 230 041 0
R1031	Res., 12 k $\pm$ 5 %, 1/4 W, metal	74 230 044 0
R1031b	Same as R1030b	
R1032	Res., 1 k $\pm$ 5 %, 1/4 W, metal	74 230 103 0
R1032b	Res., 1.2 k $\pm$ 5 %, 1/4 W, metal	74 230 050 0
R1033	Res., 180 k $\pm$ 5 %, 1/4 W, metal	74 253 133 0
R1034a	Res., B10 k, B10 k var., (H. POSITION), 0.25 W, with push pull switch, carbon	74 325 271 0
R1034b	Same as R1034a [(PULL x 10 MAG) FINE]	
R1035	Res., 10 k $\pm$ 5 %, 1/4 W, metal	74 230 012 0
R1040	Res., 51 $\pm$ 5 %, 1/4 W, metal	74 230 060 0
R1041	Res., 47 $\pm$ 5 %, 1/4 W, metal	74 230 010 0
R1042	Res., 24 k $\pm$ 5 %, 1/4 W, metal	74 230 032 0
R1043	Res., 43 $\pm$ 5 %, 1/4 W, metal	74 230 122 0
R1044	Res., 22 $\pm$ 5 %, 1/4 W, metal	74 230 087 0
R1045	Res., 13 k $\pm$ 2 %, 1 W, carbon	74 242 055 0
R1047	Same as R1030b	
R1048	Res., 180 $\pm$ 5 %, 1/4 W, metal	74 230 086 0
R1050	Res., 15 k $\pm$ 5 %, 1/4 W, metal	74 230 014 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R1051	Res., B10 k var., (Mag Gain) 0.1 W, metal	74 349 091 0
R1060	Same as R1030b	
R1061	Res., B1 k var., (Normal Gain) 0.1 W, metal	74 349 128 0
R1070	Same as R1001 (Mag Center)	
R1071	Same as R1000	
R1080	Res., 9.1 k $\pm$ 5 %, 1/4 W, metal	74 230 109 0
R1090	Res., 10 $\pm$ 5 %, 1/4 W, metal	74 230 007 0
R1091	Same as R1090	
R1092	Same as R1044	
R1100	Res., 51 $\pm$ 5 %, 1/4 W, compo.	74 253 076 0
R1101	Res., 39 $\pm$ 5 %, 1/4 W, metal	74 230 103 0
R1102	Res., 360 $\pm$ 0.5 %, 1/8 W, metal	74 221 165 0
R1103	Res., 1 k $\pm$ 2 %, 1/2 W, carbon	74 241 044 0
R1104	Res., B10 k var., 0.08 W, carbon	74 349 037 0
R1105	Res., 68 $\pm$ 5 %, 1/4 W, metal	74 230 105 0
R1106	Res., 820 $\pm$ 5 %, 1/4 W, metal	74 230 049 0
R1107	Res., 762 $\pm$ 0.5 %, 1/2 W, metal	74 231 110 0
R1108	Res., 27 $\pm$ 5 %, 1/4 W, metal	74 230 138 0
R1109	Res., 680 $\pm$ 5 %, 1/4 W, metal	74 230 015 0
R1112	Same as R1030	
R1113	Res., 3.3 k $\pm$ 0.5 %, 1/8 W, metal	74 221 103 0
R1114	Res., 2.7 k $\pm$ 0.5 %, 1/8 W, metal	74 241 107 0
R1115	Same as R1041	
R1116	Same as R1100	
R1117	Res., 6.2 k $\pm$ 0.5 %, 1/2 W, metal	74 221 109 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R1120	Res., 36 $\pm$ 5 %, 1/4 W, metal	74 230 149 0	R1149	Same as R1043	
R1121	Same as R1042		R1152	Res., 20 $\pm$ 5 %, 1/4 W, metal	74 230 114 0
R1122	Res., 91 $\pm$ 5 %, 1/4 W, metal	74 230 123 0	R1153	Same as R1044	
R1123	Res., 22 $\pm$ 5 %, 1/4 W, compo.	74 253 069 0	R1154	Same as R1145	
R1124	Res., 24 $\pm$ 5 %, 1/4 W, compo.	74 253 154 0	R1155	Same as R1145	
R1125	Res., 560 $\pm$ 5 %, 1/4 W, metal	74 230 058 0	R1156	Same as R1133	
R1126	Same as R1108		R1157	Res., 20 $\pm$ 2 %, 1/2 W, carbon	74 241 004 0
R1127	Res., 620 $\pm$ 5 %, 1/4 W, metal	74 230 104 0	R1158	Same as R1044	
R1128	Res., 3.3 k $\pm$ 1 %, 1/6 W, metal	74 230 135 0	R1160	Same as R1030b	
R1129	Same as R1128		R1161	Res., B1 k var., 0.08 W, carbon	74 349 033 0
R1130	Same as R1101		R1170	Res., 150 k $\pm$ 2 %, 1/4 W, carbon	74 244 020 0
R1131	Res., 68 $\pm$ 5 %, 1/4 W, compo.	74 253 043 0	R1170b	Res., 510 k $\pm$ 2 %, 1/2 W, carbon	74 241 106 0
R1132	Res., 47 $\pm$ 5 %, 1/4 W, compo.	74 253 007 0	R1171	Same as R1170	
R1133	Res., 2 k $\pm$ 5 %, 10 W, W.W. (Non Induction)	74 220 013 0	R1171b	Same as R1170b	
R1134	Res., 91 $\pm$ 2 %, 1/2 W, carbon	74 241 019 0	R1190	Same as R1090	
R1135	Res., 3 k $\pm$ 5 %, 10 W, W.W. (Non Induction)	74 220 021 0	R1191	Same as R1090	
R1136	Res., 36 $\pm$ 2 %, 1/2 W, carbon	74 241 010 0	R1192	Same as R1090	
R1140	Res., 8.2 k $\pm$ 0.5 %, 1/8 W, metal	74 221 164 0	R1193	Same as R1040	
R1141	Same as R1114			DIODES	
R1142	Res., 1.42 k $\pm$ 0.5 %, 1/4 W, metal	74 221 111 0	D1000	Diode 1S1458	74 040 292 0
R1143	Res., 390 $\pm$ 5 %, 1/4 W, metal	74 230 055 0	D1001	Same as D1000	
R1145	Res., 5.1 k $\pm$ 1 %, 1/6 W, metal	74 230 136 0	D1002	Diode 1S953	74 040 172 0
R1146	Same as R1145		D1003	Z. Diode HW6.8A	74 040 415 0
R1147	Res., 240 $\pm$ 5 %, 1/4 W, metal	74 230 125 0	D1004	Same as D1002	
R1148	Same as R1000		D1005	Same as D1002	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D1010	Same as D1000	
D1011	Same as D1000	
D1050	Z. Diode 1S551	74 040 064 0
D1120	Z. Diode 1N754A	74 040 326 0
D1121	Diode 1S955	74 040 184 0
D1122	Same as D1121	
D1140	Same as D1002	
D1141	Z. Diode HW33A	74 040 301 0
D1154	Same as D1121	
D1155	Same as D1121	
D1160	Same as D1000	

TRANSISTORS

TR1001	Transistor 2N4275	74 030 316 0
TR1001	Transistor 2N4258	74 030 315 0
TR1002	Same as TR1000	
TR1100	Transistor BFW-30	74 030 462 0
TR1101	Transistor 2N5179	74 030 431 0
TR1110	Same as TR1100	74 030 431 0
TR1111	Same as TR1000	
TR1120	Same as TR1101	
TR1121	Same as TR1100	
TR1122	Transistor 2N3119	74 030 183 0
TR1130	Transistor 2N3495	74 030 494 0
TR1140	Transistor 2N4121	74 030 299 0
TR1141	Same as TR1140	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TR1142	Transistor 2N3637	74 030 464 0
TR1160	Same as TR1000	

NEON LAMPS

NE1101	Neon Lamp NE-2 (Position Indicator)	74 020 111 0
NE1102	Same as NE1101	
	Socket of Neon Lamp Type C	74 480 149 0

RELAYS

RL1000	Relay TO-5 712-12	74 450 106 0
RL1001	Same as RL1000	

SWITCH

S1001	Lever Switch LSP1-3-3	74 440 169 0
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HEAT DISSIPATOR

	Semiconductor Heat Dissipator TXBF-2P-032-037	74 030 363 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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Z-AXIS AMPLIFIER

CAPACITORS

C1201	Cap., 0.01 μ F ± 10 %, 150 WVDC, cer.	74 060 046 0
C1202	Cap., 18 pF ± 10 %, 50 WVDC, cer.	74 050 396 0
C1203	Cap., 2200 pF -0 - +100 %, 500 WVDC, cer.	74 060 084 0
C1205	Cap., 33 pF ± 10 %, 50 WVDC, cer.	74 050 391 0
C1212	Cap., 100 pF ± 10 %, 50 WVDC, cer.	74 050 171 0
C1219	Cap., 47 pF ± 10 %, 50 WVDC, cer.	74 050 273 0
C1220	Cap., 27 pF ± 10 %, 50 WVDC, cer.	74 050 576 0
C1224	Cap., 1 pF ± 0.5 pF, 50 WVDC, cer.	74 050 477 0
C1236	Cap., 3 pF - 7 pF var., 250 WVDC, cer.	74 110 060 0
C1237	Cap., 0.5 pF - 1.5 pF var., 500 WVDC, cer.	74 110 029 0
C1251	Cap., 0.01 μ F -0 - +100 %, 500 WVDC, cer.	74 060 073 0
C1252	Same as C1251	
C1253	Same as C1201	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
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COIL

L1201	Inductor, (Ferrite Bead Core) L82 OP-03-03-1H	74 560 124 0
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RESISTORS

R1201	Res., 47 ± 5 %, 1/4 W, metal	74 230 010 0
R1202	Same as R1201	
R1203	Res., 1 k ± 5 %, 1/4 W, metal	74 230 003 0
R1204	Res., 680 ± 5 %, 1/4 W, metal	74 230 015 0
R1205	Res., 470 ± 5 %, 1/4 W, metal	74 230 016 0
R1206	Same as R1201	
R1207	Res., 6.8 k ± 5 %, 1/4 W, metal	74 230 033 0
R1211	Same as R1203	
R1212	Res., 2 k ± 5 %, 1/4 W, metal	74 230 041 0
R1213	Same as R1203	
R1214	Same as R1203	
R1215	Same as R1203	
R1216	Res., 22 k ± 5 %, 1/4 W, metal	74 230 032 0
R1217	Same as R1203	
R1218	Same as R1203	
R1219	Same as R1216	
R1220	Res., 100 k ± 5 %, 1/4 W, metal	74 230 026 0
R1221	Same as R1203	
R1222	Res., 10 ± 5 %, 1/4 W, metal	74 230 007 0
R1223	Res., 33 ± 5 %, 1/4 W, metal	74 230 028 0

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R1224	Res., 30 k $\pm$ 5 %, 1/2 W, carbon	74 241 076 0
R1225	Res., 100 $\pm$ 5 %, 1/4 W, metal	74 230 013 0
R1226	Res., 43 k $\pm$ 5 %, 1/4 W, metal	74 230 131 0
R1227	Same as R1222	
R1228	Res., 1.5 k $\pm$ 5 %, 1/4 W, metal	74 230 011 0
R1229	Same as R1204	
R1231	Same as R1228	
R1232	Res., B5 k var., (INTENSITY), 0.1 W, metal	74 349 167 0
R1233	Same as R1222	
R1234	Same as R1212	
R1235	Res., 10 $\pm$ 5 %, 1/8 W, compo.	74 257 002 0
R1236	Same as R1225	
R1237	Res., 10 k $\pm$ 2 %, 1/2 W, carbon	74 241 066 0
R1238	Same as R1203	
R1239	Res., 10 k $\pm$ 5 %, 1/4 W, compo.	74 253 116 0
R1240	Same as R1220	
R1241	Same as R1204	
R1242	Same as R1235	
R1243	Res., 20 k $\pm$ 5 %, 1/8 W, compo.	74 257 109 0
R1244	Same as R1243	
R1245	Same as R1243	
R1246	Same as R1243	
R1247	Same as R1243	
R1251	Same as R1222	
R1252	Same as R1222	
R1253	Res., 20 $\pm$ 5 %, 1/4 W, metal	74 230 114 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
DIODES		
D1201	Diode 1S913	74 040 172 0
D1202	Same as D1201	
D1203	Same as D1201	
D1204	Z. Diode RD6A	74 040 079 0
TRANSISTORS		
TR1201	Transistor 2N4121	74 030 299 0
TR1202	Transistor 2N4275	74 030 316 0
TR1203	Same as TR1202	
TR1204	Same as TR1201	
TR1205	Transistor 2N4258	74 030 315 0
TR1206	Same as TR1205	
TR1207	Same as TR1202	
TR1208	Same as TR1202	
TR1209	Same as TR1202	
TR1210	Same as TR1202	
TR1211	Same as TR1202	
TR1212	Transistor 2SC154C	74 030 400 0
TR1213	Same as TR1201	
TR1214	Same as TR1201	
TR1215	Same as TR1201	
TR1216	Same as TR1201	
TR1217	Same as TR1201	
TR1218	Same as TR1201	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
CONNECTOR		
J1201	Connector Type BNC UG625/U-Ni (Z-AXIS-INPUT)	74 500 253 0
TRANSFORMER		
T1201	Pulse Transformer	74 400 477 0
CORD		
W1201	Microphone Cord (Approximately 60 cm)	5284 12 001
HEAT DISSIPATOR		
	Semiconductor Heat Dissipator TXBF-019-025	74 030 258 0
	Semiconductor Heat Dissipator KQB-6	74 030 390 0
CRT CIRCUIT		
CAPACITORS		
C1300	Cap., 0.1 μ F ± 10 %, 50 WVDC, poly.	74 130 247 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1301	Cap., 0.047 μ F ± 10 %, 50 WVDC, poly.	74 130 201 0
C1302	Cap., 330 μ F -10 - +100 %, 50 WVDC, elect.	74 120 013 0
C1303	Cap., 0.015 μ F -0 - +100 %, 3 kVDC, cer.	74 060 196 0
C1304	Cap., 0.001 μ F -0 - +100 %, 7 kVDC, cer.	74 060 263 0
C1305	Same as C1304	
C1306	Same as C1303	
C1307	Same as C1304	
C1308	Same as C1304	
C1309	Cap., 0.01 μ F -0 - +100 %, 500 WVDC, cer.	74 060 073 0
C1310	Same as C1309	
C1311	Same as C1309	
C1312	Cap., 0.001 μ F -10 - +100 %, 3 kVDC, cer.	74 060 274 0
C1313	Same as C1303	
C1315	Same as C1315	
C1316	Same as C1309	
C1317	Cap., 250 pF ± 10 %, 20 KVDC, cer.	74 060 273 0
C1318	Cap., 0.005 μ F -0 - +100 %, 3 KVDC, cer.	74 060 201 0
C1319	Cap., 0.001 μ F -0 - +100 %, 3 KVDC, cer.	74 060 274 0
C1320	Same as C1318	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C13021	Same as C1309	
RESISTORS		
R1300	Res., B100 k var., (H.V. Adj), 0.1 W, carbon	74 349 065 0
R1301	Res., 4.7 M $\pm 5\%$, 1/2 W, compo.	74 254 073 0
R1302	Res., 1.3 M $\pm 5\%$, 1/2 W, compo.	74 254 085 0
R1303	Res., 10 k $\pm 5\%$, 1/4 W, metal	74 230 012 0
R1304	Same as R1303	
R1305	Res., 120 $\pm 5\%$, 1/4 W, metal	74 230 113 0
R1306	Res., 130 k $\pm 5\%$, 1/4 W, compo.	74 254 087 0
R1307	Res., 100 k $\pm 5\%$, 1/4 W, metal	74 230 026 0
R1308	Res., 2 M $\pm 5\%$, 1/2 W, compo.	74 282 008 0
R1309	Res., B1 M var., (Int. Adj), 0.15 W, compo.	74 345 031 0
R1310	Res., 15 M $\pm 10\%$, 2 W, compo.	74 256 007 0
R1311	Res., 2.2 M $\pm 5\%$, 1 W, compo.	74 283 007 0
R1312	Res., 3 M $\pm 5\%$, 1/2 W, compo.	74 254 064 0
R1313	Res., 5.6 M $\pm 5\%$, 1 W, compo.	74 255 049 0
R1315	Same as R1313	
R1317	Same as R1313	
R1319	Res., 3.3 M $\pm 5\%$, 1/2 W, compo.	74 254 054 0
R1320	Same as R1313	
R1321	Res., B100 k var., (Geom), 0.5 W, carbon	74 345 025 0
R1322	Res., B2 k var., (Trace Rotation), 4 W, W.W.	74 331 043 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1323	Res., 200 $\pm 5\%$, 1/2 W, carbon	74 241 027
C1324	Same as R1322 (Ortho 1)	
R1325	Same as R1323	
R1326	Same as R1322 (Ortho 2)	
R1327	Same as R1321 (Inter shield)	
R1328	Res., 3 k $\pm 5\%$, 1/2 W, carbon	74 241 053 0
R1329	Res., 11 k $\pm 5\%$, 1/2 W, carbon	74 241 124 0
R1330	Same as R1321 (Astig)	
R1331	Res., 10 k $\pm 5\%$, 1/2 W, carbon	74 241 066 0
R1332	Res., 4.3 M $\pm 5\%$, 1/2 W, compo.	74 254 086 0
R1333	Same as C1332	
R1334	Same as C1332	
R1335	Same as C1332	
R1336	Same as C1332	
R1337	Same as R1331	
R1338	Res., B2M var., (FOCUS), 0.1 W, selected, carbon	74 322 171 0
R1340	Same as R1307	
R1341	Same as R1331	
R1342	Res., 1 M $\pm 5\%$, 1/2 W, carbon	74 241 113 0
R1343	Res., 100 $\pm 2\%$, 1/2 W, carbon	74 241 020 0
R1344	Res., 15 k $\pm 2\%$, 1/2 W, carbon	74 241 069 0
R1345	Same as R1343	

DIODES

D1300	Diode, 1S955	74 040 184 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D1301	Diode, LA60 (High Voltage Rectifier, silicon)	74 040 213 0
D1302	Diode, 5EH12 (High Voltage Rectifier, silicon)	74 040 334 0
D1303	Same as D1302	
D1304	Same as D1302	
D1305	Same as D1302	
D1306	Same as D1301	
D1310	Diode, M4C-1	74 040 388 0

TRANSISTOR

TR1301	Transistor, 2SD93	74 030 376 0
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INTEGRATED CIRCUIT

IC1300	Integrated Circuit, LA50321	74 030 533 0
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NEON LAMPS

NE1301	Neon Lamp NE-2	74 020 111 0
NE1302	Same as NE1301	
NE1303	Same as NE1301	

FUSE

F1301	Fuse (Slow Blow, 0.5 A, 15.2 ϕ x 20 ℓ)	74 540 002 0
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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TRANSFORMER		
T1301	Transformer, High Voltage DSC. Okiseid Core 22-58	74 472 116 0 74 560 062 0
CATHODE RAY TUBE		
V1301	CRT. D10-200GH/07 Socket pin of Vacuum Tube Anode Cap of CRT.	74 010 108 0 74 080 028 0 74 480 022 0

POWER SUPPLY

CAPACITORS

C1401	Cap., 47 μ F -10 - 100 %, 16 WVDC, elect.	74 120 309 0
C1403	Cap., 2200 μ F -10 - +100 %, 25 WVDC, elect.	74 120 376 0
C1404	Cap., 0.01 μ F -20 - +80 %, 50 WVDC, cer.	74 060 058 0
C1405	Cap., 33 μ F $\pm$ 20 %, 10 WVDC, elect. tan	74 120 395 0
C1406	Cap., 10 μ F $\pm$ 20 %, 16 WVDC, elect. tan	74 120 186 0
C1407	Same as C1403	

CHAPTER 7 PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1408	Same as C1404	
C1409	Same as C1405	
C1410	Same as C1406	
C1411	Cap., 1000 μ F -10 — +100 %, 63 WVDC, elect.	74 120 230 0
C1412	Same as C1411	
C1413	Cap., 0.1 μ F $\pm$ 20 %, 250 WVDC, poly.	74 130 328 0
C1414	Same as C1404	
C1415	Cap., 0.001 μ F -20 — +80 %, 50 WVDC, cer.	74 060 175 0
C1416	Cap., 2.2 μ F, 100 WVDC, elect. tan	74 120 464 0
C1417	Cap., 15 μ F, 75 WV, elect. tan	74 120 268 0
C1418	Cap., 680 μ F -10 — +100 %, 63 WVDC, elect.	74 130 280 0
C1419	Same as C1413	
C1420	Same as C1415	
C1421	Cap., 2.2 μ F, 150 WVDC, elect. tan	74 120 211 0
C1422	Cap., 220 μ F -10 — +100 %, 50 WVDC, elect.	74 120 284 0
C1423	Same as C1413	
C1424	Same as C1415	
C1425	Same as C1421	
C1426	Cap., 22 μ F -10 — +100 %, 100 WVDC, elect.	74 120 257 0
C1427	Same as C1401	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1428	Cap., 1 μ F -5 — +20 %, 110 VAC, paper	74 080 120 0
C1429	Same as C1421	
C1430	Same as C1406	
C1431	Same as C1406	
C1432	Cap., 0.001 μ F -0 — +100 %, 250 WVDC, cer.	74 060 018 0

RESISTORS

R1401	Res., 51 k $\pm$ 5 %, 1/2 W, carbon	74 241 082 0
R1402	Res., 39 $\pm$ 5 %, 1/2 W, carbon	74 241 034 0
R1403	Res., 0.3 $\pm$ 5 %, 1 W, W.W.	74 228 063 0
R1404	Res., 100 $\pm$ 5 %, 1/4 W, metal	74 230 013 0
R1405	Res., 120 $\pm$ 5 %, 1/4 W, metal	74 230 113 0
R1406	Res., 1.1 k $\pm$ 1 %, 1/4 W, metal	74 221 123 0
R1407	Res., B200 var., (-12 V Adj), 0.5 W, W.W.	74 331 057 0
R1408	Res., 392 $\pm$ 1 %, 1/4 W, metal	74 221 122 0
R1409	Res., B50 var., (SCALE ILLUM), 0.5 W, W.W.	74 331 064 0
R1410	Same as R1403	
R1411	Same as R1404	
R1412	Same as R1405	
R1413	Same as R1406	
R1414	Same as C1407 (+12 V Adj)	
R1415	Same as R1408	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.	CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R1416	Res., 10 k $\pm$ 5 %, 1/4 W, metal	74 230 012 0	R1446	Same as R1401	
R1417	Res., 39 k $\pm$ 5 %, 1/4 W, metal	74 230 078 0	R1447	Same as R1442	
R1418	Same as R1405		R1448	Same as R1442	
R1419	Res., 470 $\pm$ 5 %, 1/4 W, metal	74 230 016 0	R1449	Res., 10 $\pm$ 5 %, 1/2 W, carbon	74 241 001 0
R1420	Res., 0.8 $\pm$ 5 %, 1 W, W.W.	74 228 064 0	R1450	Same as R1448	
R1421	Res., 17.4 k $\pm$ 0.5 %, 1/2 W, metal	74 221 127 0	R1451	Same as R1442	
R1422	Res., 3.01 k $\pm$ 0.5 %, 1/8 W, metal	74 221 124 0	R1452	Same as R1442	
R1423	Res., 100 $\pm$ 5 %, 5 W, W.W.	74 230 015 0			
R1425	Same as R1416		DIODES		
R1426	Res., 27 k $\pm$ 5 %, 1/4 W, metal	74 230 039 0	D1401	Diode, VO3C (Rectifier)	74 040 335 0
R1427	Same as R1405		D1402	Z. Diode HW6.8 A	74 040 415 0
R1428	Same as R1419		D1403	Same as D1401	
R1429	Res., 6.2 $\pm$ 5 %, 1 W, W.W.	74 228 066 0	D1404	Same as D1401	
R1430	Res., 40.2 k $\pm$ 0.5 %, 1/2 W, metal	74 221 128 0	D1405	Same as D1401	
R1431	Res., 4.41 k $\pm$ 0.5 %, 1/8 W, metal	74 221 125 0	D1406	Same as D1401	
R1433	Same as R1416		D1407	Z. Diode 1S552	74 040 322 0
R1434	Res., 33 k $\pm$ 5 %, 1/4 W, metal	74 230 030 0	D1408	Same as D1401	
R1435	Same as R1405		D1409	Same as D1401	
R1436	Same as R1419		D1410	Same as D1401	
R1437	Res., 3.6 $\pm$ 5 %, 1 W, W.W.	74 228 065 0	D1411	Same as D1401	
R1438	Res., 53.6 k $\pm$ 0.5 %, 1/2 W, metal	74 221 129 0	D1412	Same as D1407	
R1439	Res., 4.97 k $\pm$ 0.5 %, 1/8 W, metal	74 221 126 0	D1413	Diode, VO6E (Rectifier)	74 040 380 0
R1440	Res., 1.2 k $\pm$ 2 %, 1/2 W, carbon	74 241 045 0	D1414	Same as D1413	
R1442	Res., 27 k $\pm$ 5 %, 1/2 W, carbon	74 241 075 0	D1415	Same as D1413	
R1443	Same as R1442		D1416	Same as D1413	
R1444	Res., 100 k $\pm$ 5 %, 1/2 W, carbon	74 241 089 0	D1417	Z. Diode HW56A	74 040 329 0
R1445	Same as R1444				

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D1418	Diode 1S953	74 040 172 0
D1419	Same as D1418	
D1420	Same as D1401	
D1421	Same as D1401	
D1422	Same as D1401	
D1423	Same as D1401	
D1424	Same as D1401	
D1425	Z. Diode HW68A	74 040 375 0
D1426	Same as D1418	
D1427	Same as D1418	
D1428	Same as D1401	
D1429	Same as D1401	
D1430	Same as D1401	
D1431	Same as D1401	
D1432	Same as D1401	
D1433	Z. Diode HW91A	74 040 324 0
D1434	Same as D1418	
D1435	Same as D1418	
D1436	Same as D1401	
D1437	Same as D1401	
D1438	Same as D1401	
D1439	Z. Diode HW33A	74 040 301 0
D1440	Same as D1418	
D1441	Same as D1418	
D1442	Same as D1418	
D1443	Same as D1418	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TRANSISTORS		
TR1401	Transistor 2SD221	74 030 401 0
TR1402	Transistor 2N3055	
TR1405	Transistor 2SD650B	
TR1406	Transistor 2SC510 (O)	
TR1407	Transistor 2SD166	
TR1408	Transistor 2SD221G	
TR1411	Same as TR1401	
TR1412	Same as TR1402	
TR1415	Same as TR1405	
TR1416	Same as TR1406	
TR1417	Transistor 2SD198	74 030 465 0
TR1418	Same as TR1408	
TR1425	Same as TR1405	
TR1426	Same as TR1401	
TR1427	Same as TR1417	
TR1428	Same as TR1408	
INTEGRATED CIRCUIT		
IC1401	Integrated Circuit, VC-10311	74 030 470 0
IC1402	Same as IC1401	
NEON LAMP		
NE1401	Neon Bracket Lamp BNF-3	74 020 177 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
SWITCHES		
S1401	Toggle Switch MST206N (POWER ON)	74 430 037 0
S1402	Same as S1401 (100 V — 115 V select)	
FUSES		
F1401	Fuse (Slow Blow) 2 A, 5.2 ϕ x 20 ℓ	74 540 070 0
F1402	Fuse 0.25 A, 5.2 ϕ x 20 ℓ	74 540 003 0
F1403	Same as F1402	
F1404	Fuse 0.5 A, 5.2 ϕ x 20 ℓ	74 540 005 0
TRANSFORMER		
T1401	Power Transformer	74 471 219 0
ILLUMINATION LAMPS		
PL1401	Scale Illumination Lamp 6.3 V, 150 mA	74 490 015 0
PL1402	Same as PL1401	
SOCKET		
	Socket of Illumination Lamp E-5	74 480 131 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
THERMO RELAY		
RL1401	Thermostat TS-11C, 80°C open, 60°C $\pm$ 5°C close	74 450 117 0
FAN MOTOR		
	Fan motor MRQ8-B	74 550 020 0
POWER CORD		
	Power Cord, 3 meters with plug	74 470 135 0
FUSE HOLDER		
	Fuse Holder (medium)	74 480 095 0
	Fuse Holder (small)	74 480 188 0
BERYLLIA		
	Ceramic (Beryllia) 1GC-47012	74 030 145 0
CALIBRATOR		
CAPACITORS		
C1501	Cap., 0.047 μ F $\pm$ 10 %, 50 WVDC, poly.	74 130 201 0

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CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C1502	Cap., 33 μ F -10 — +100 %, 16 WVDC, elect.	74 120 219 0
C1503	Cap., 0.1 μ F -2 — +0 %, 50 WVDC, poly.	74 130 177 0
RESISTORS		
R1501	Res., B500 var., 0.1 W, metal	74 349 076 0
R1502	Res., 1.6 k $\pm$ 5 %, 1/4 W, metal	74 230 132 0
R1503	Res., 360 $\pm$ 1 %, 1/4 W, metal	74 221 088 0
R1504	Res., 36 $\pm$ 1 %, 1/4 W, metal	74 221 089 0
R1505	Res., 8 $\pm$ 1 %, 1/4 W, carbon	74 212 189 0
R1506	Same as R1505	
R1507	Res., 2.2 $\pm$ 5 %, 1/4 W, compo.	74 253 001 0
R1508	Res., 200 $\pm$ 2 %, 1/2 W, carbon	74 241 027 0
INTEGRATED CIRCUIT		
IC1501	Integrated Circuit, LG632	74 030 469 0

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
SWITCH		
S1501	Lever Switch, LSP1-1-3 (CAL)	74 440 154 0
CONNECTOR		
J1501	Connector, Type BNC UG625/U-Ni (CAL OUT)	74 500 253 0
TERMINATION		
TB1501	Termination, 8 ϕ (GND)	74 510 014 0
TRANSFORMER		
T1501	Transformer (CAL. OSC.) Pot Core, H6BP 18/14-T32 Bobin, BP 18/14-122 Core Belt, FP 18/14-2	74 472 082 0 74 560 086 0 74 520 097 0 74 560 087 0

MEMO

Abbreviations used in this manual are as follows:

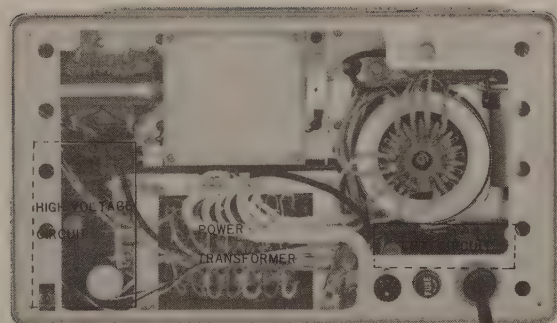
◆ For units :

A	ampere
mA	milliampere
μ A	microampere
nA	nanoampere (10^{-9} A)
dB	decibel
div (DIV)	division
g	gram
kg	kilogram
Hz	hertz
kHz	kilohertz
MHz	megahertz
GHz	gigahertz
m	meter
cm	centimeter
mm	millimeter
sec (SEC)	second
msec	millisecond
μ sec	microsecond
nsec	nanosecond (10^{-9} sec)
psec	picosecond (10^{-12} sec)
F	farad
μ F	microfarad
pF	picofarad
V	volt
mV	millivolt
μ V	microvolt
VA	voltampere
W	watt
mW	milliwatt
Ω	ohm
M Ω	megohm
k Ω	kilohm
rms	root mean square
p-p	peak to peak

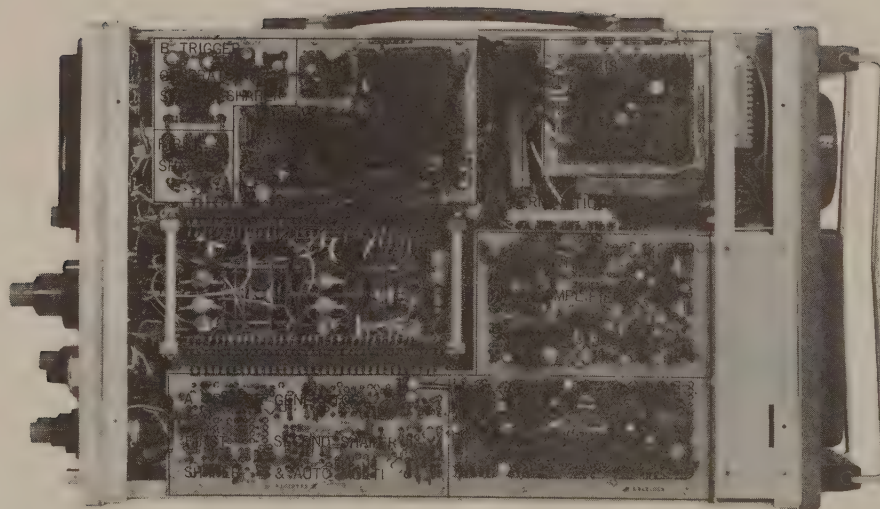
◆ Others :

AC	alternate current
ADJ	adjust
ALTER	alternate
ASTIG	astigmatism
AUTO (Auto)	automatic
BAL	balance
CAL	calibrated
CAL OUT	calibrator output
CENT	center
CH 1	channel 1
CH 2	channel 2
CHOP	chopped
DC	direct current
EXT	external
GND	ground (earth)
HF REF	high frequency reject
HORIZ	horizontal
ILLUM	illumination
INT	internal
INTEN	intensity
LF REJ	low frequency reject
MAG	magnifier
NORM	normal
SENS	sensitivity
SWP	sweep
TRIG	trigger
UNCAL	uncalibrated
VERT	vertical

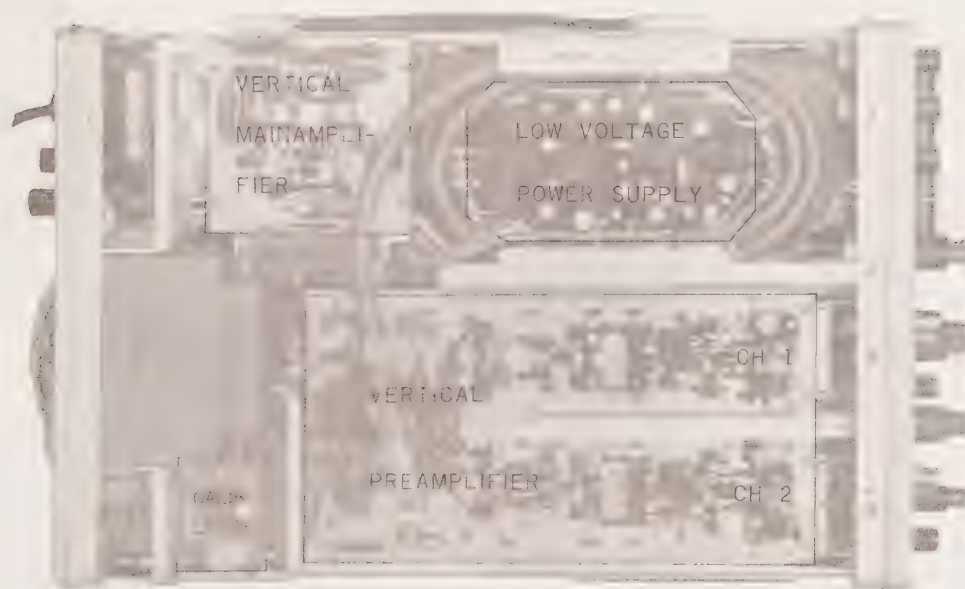
REAR VIEW



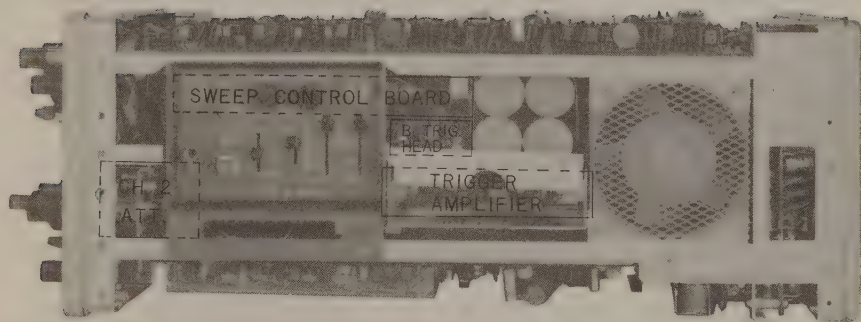
TOP VIEW



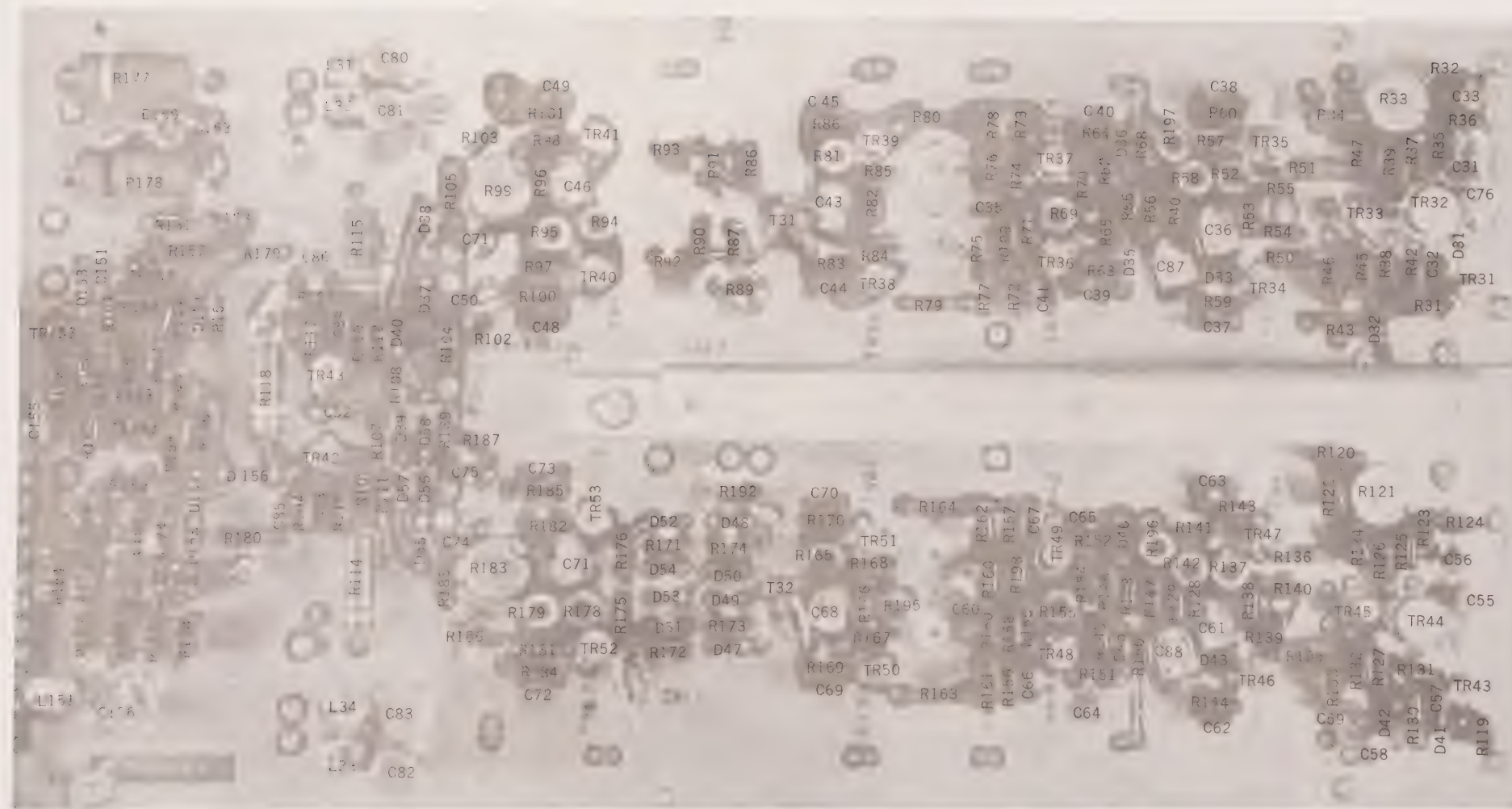
BOTTOM VIEW



RIGHT SIDE VIEW

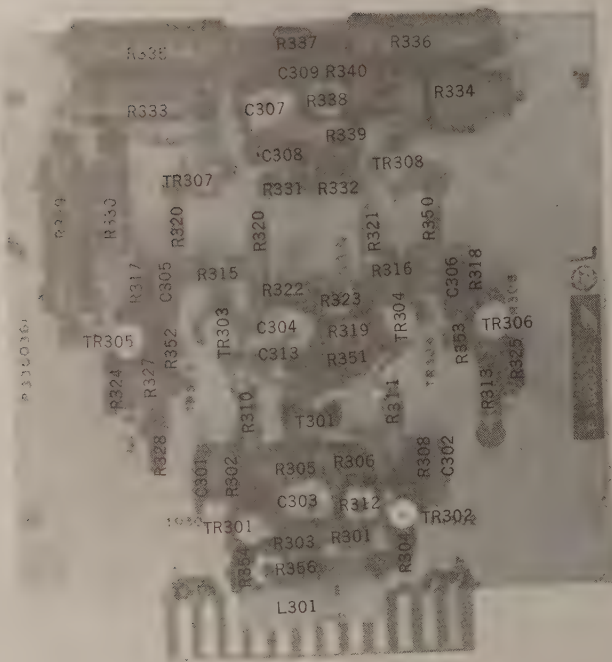


VERTICAL PREAMPLIFIER



VERTICAL MAIN AMPLIFIER

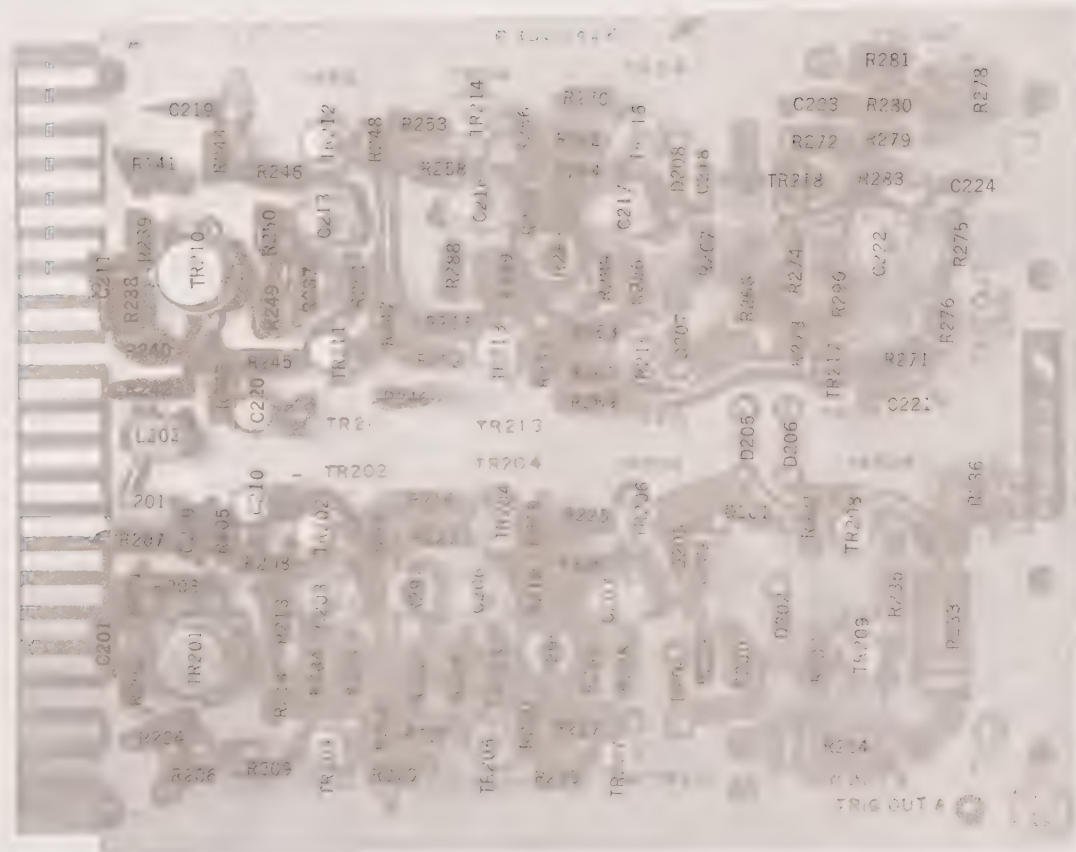
TERMINATION (VERTICAL MAIN) AMPLIFIER



A TRIGGER GENERATOR, A SWEEP GENERATOR & HORIZONTAL AMPLIFIER



TRIGGER AMPLIFIER



SWEEP CONTROL BOARD

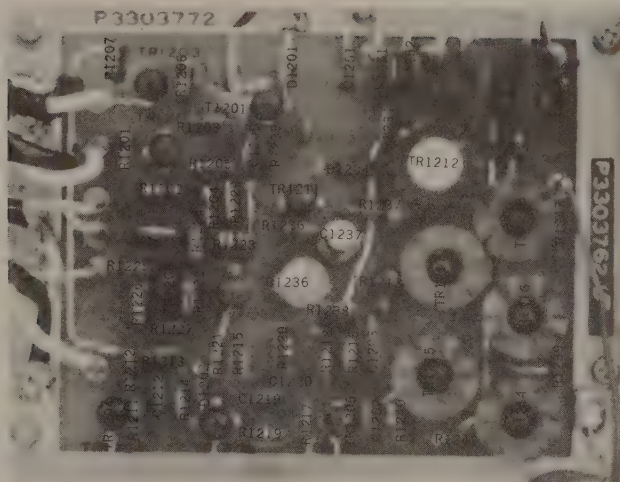


B TRIGGER HEAD (FIRST SHAPER)

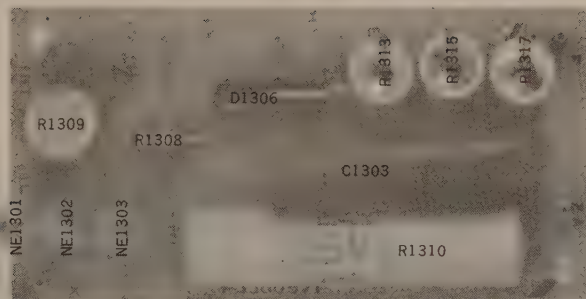


21

Z AXIS AMPLIFIER



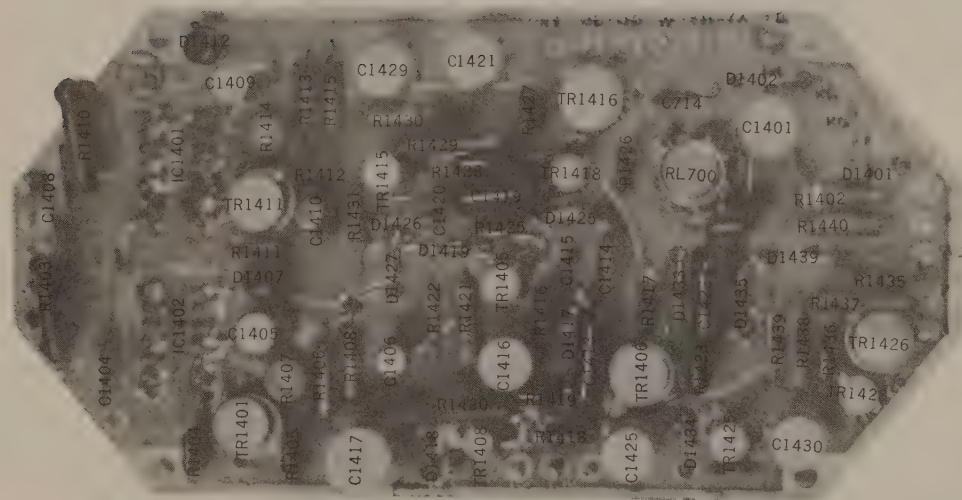
CRT CIRCUIT



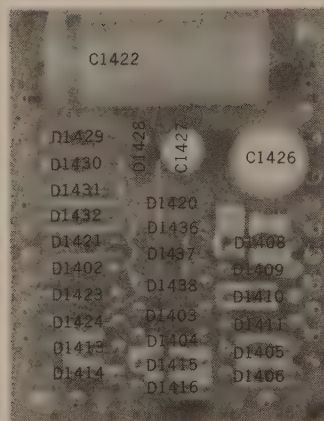
H.V. CIRCUIT



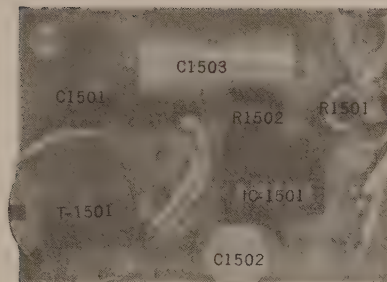
LOW VOLTAGE POWER SUPPLY

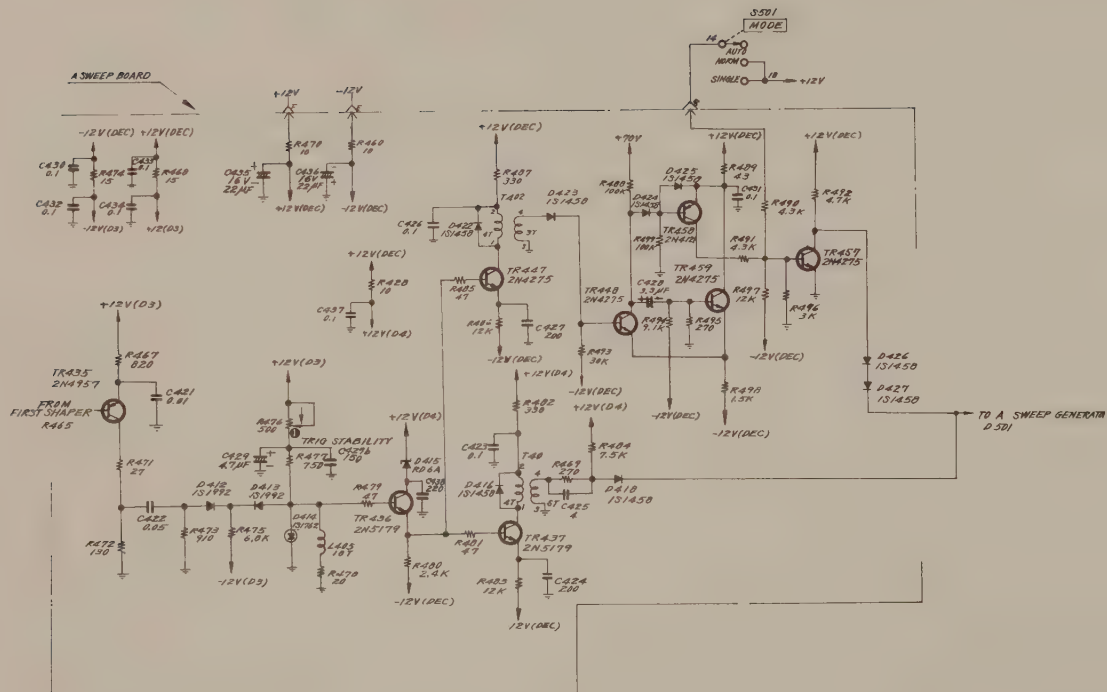


RECTIFIER BOARD (POWER SUPPLY)



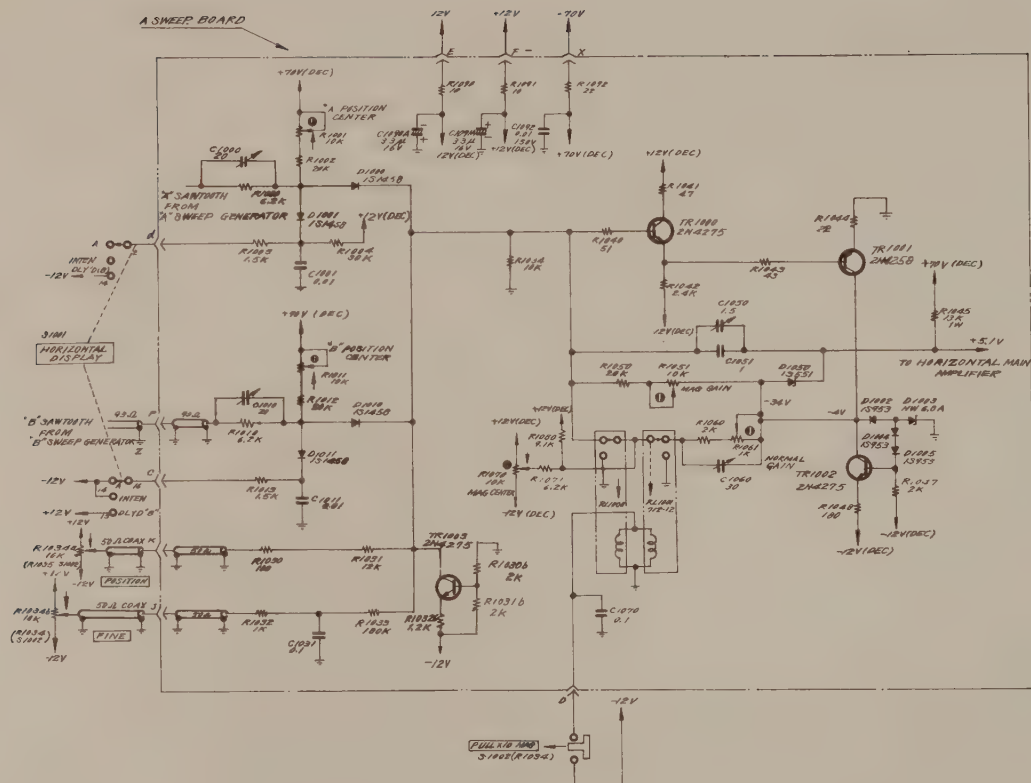
CALIBRATOR





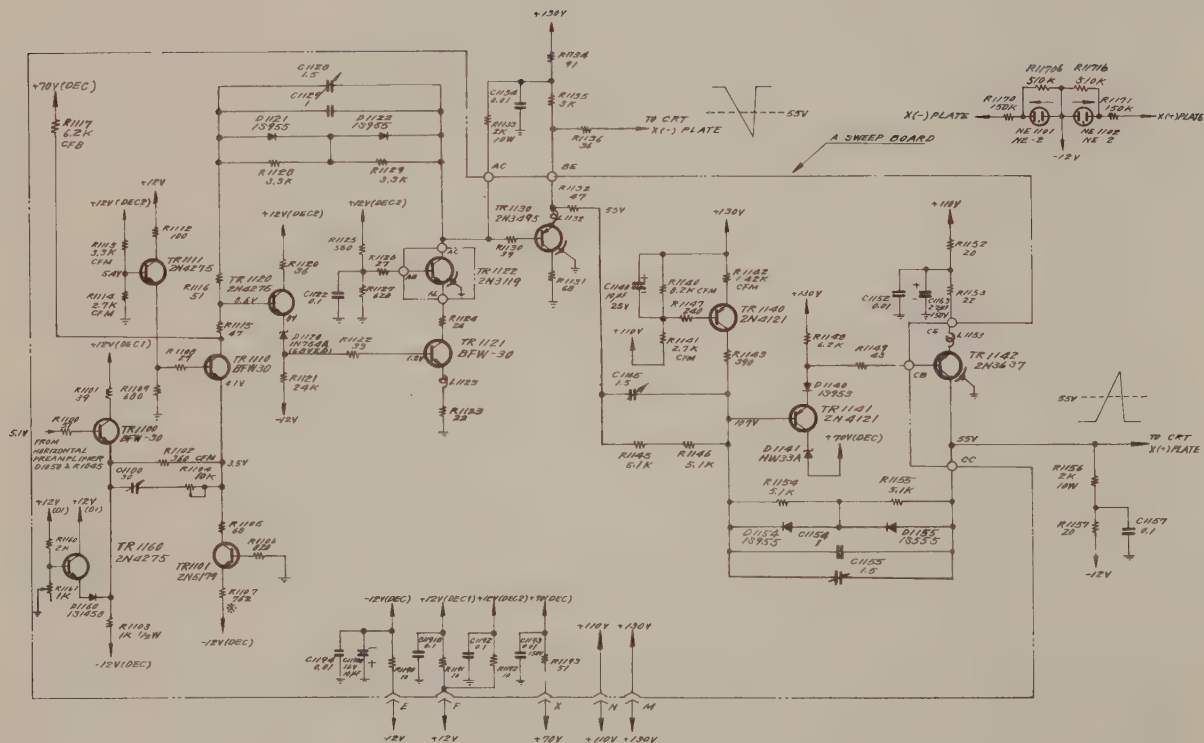
"A" TRIGGER GENERATOR SECOND SHAPER & AUTO MULTI

K-605114



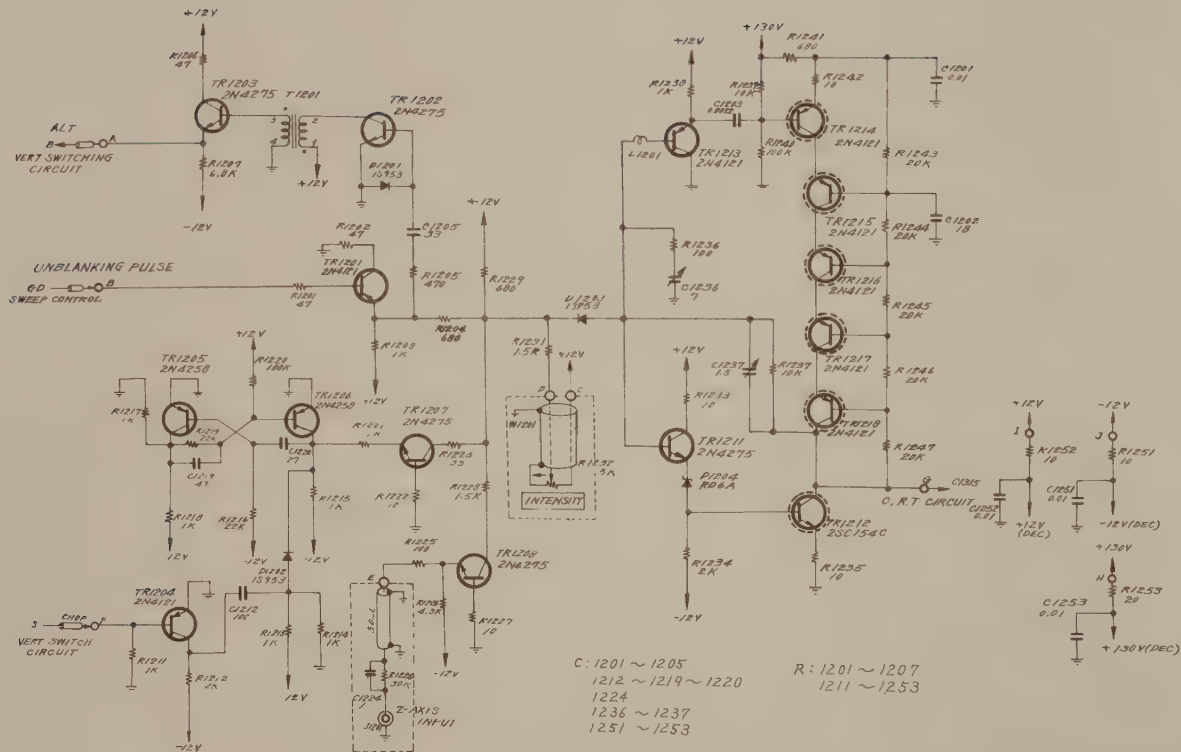
HORIZ PRE AMP

K-605118



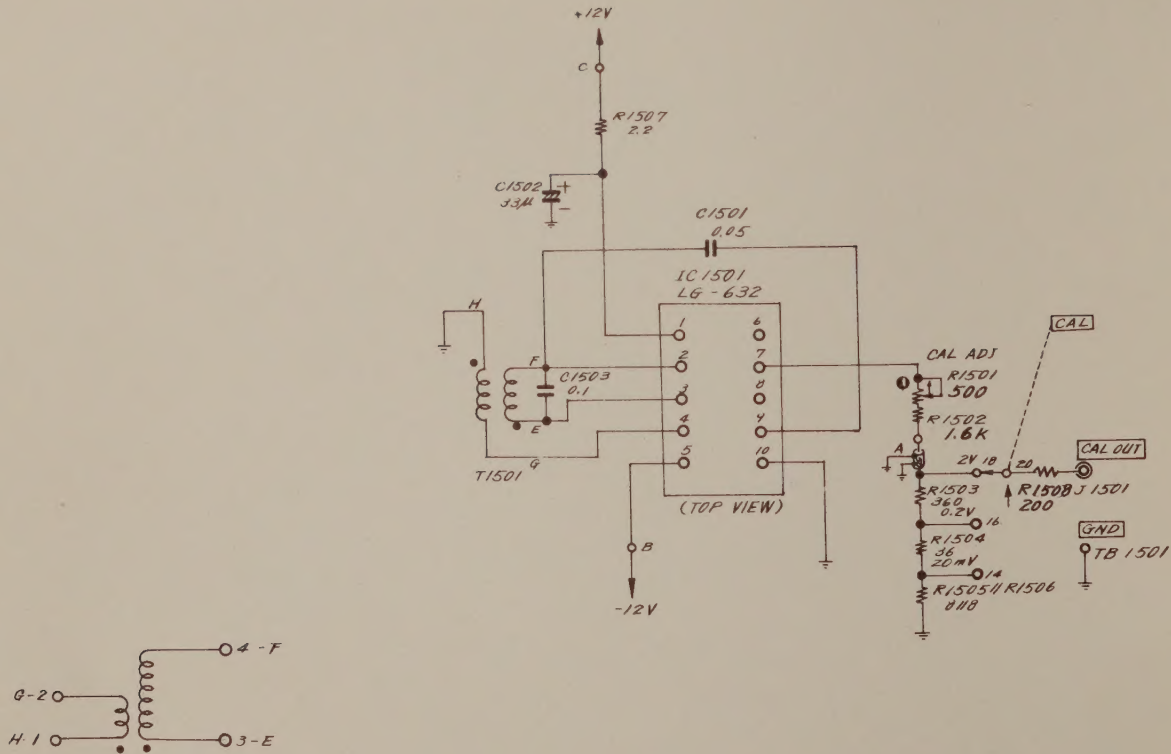
HORIZ MAIN AMP

K-605119



Z AXIS AMP

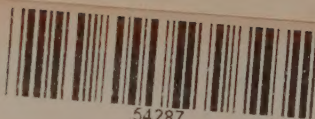
K-605124



CAL



IWATSU ELECTRIC CO., LTD.



54287

SYNCHROSCOPE
TYPE SS-200
SERIAL NO.
DATE
IWATSU ELECTRIC CO., LTD.
TOKYO JAPAN

Z AXIS
INPUT

115V 2A SLOW

